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DRAFT FINAL TECHNICAL MEMORANDUM SOIL-BACKGROUND EVALUATION FOR INORGANICS ABL ROCKET CENTER WV

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CH2MHILL

ABL Soil-Background Evaluation for Inorganics

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1.0 Objective

The objective of the technical memorandum (TM) is to report on the methods and results of determining background concentrations of inorganics in soil at the Allegany Ballistics Laboratory (ABL) Superfund Site. The evaluation estimates the concentrations of naturally-occurring inorganics that are an upper limit of the concentrations that reasonably could be expected to represent background conditions for soil on the ABL facility. In this evaluation, background is interpreted to mean concentrations resulting from natural processes, independent of the redistribution or the incremental loading that could be attributable to human activities. Concentrations above background could indicate contamination that may be due to activities on the facility and, potentially, could require remediation.

Evaluation procedures and results are presented in sections 2 through 7. Section 2 places the evaluation of facility background in the context of U.S. Environmental Protection Agency (USEPA) guidance and establishes the regulatory background for the calculations performed. Section 3 describes the general statistical approach used in the evaluation. Section 4 describes statistical methods used to accomplish the objective, including exploratory analyses and goodness-of-fit (GOF) tests, conducted before estimating the upper limits of the background concentrations. Section 5 describes the available data and the data-management procedures that were key to developing a database that was consistent with the objective. Section 6 describes the results from the preliminary procedures that determined the specific calculations that were appropriate to estimate the upper bounds of the background concentrations. Section 7 documents the parameter-specific estimates of background concentrations against which onsite concentrations may be compared. Section 8 contains the references.

2.0 Background

The regulatory framework for comparisons to background has been described in several guidance and forum papers, particularly:

- *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites* (USEPA, December 1995).
- *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance* (USEPA, April 1989).
- *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance* (USEPA, April 1992).

The USEPA forum paper (December 1995) specifically avoids dictating explicitly the methods for determining background concentrations of inorganics in soil on the premise that the paper's objective is "*to provide a discussion of the technical issues involved in establishing background and not to address agency policy-related decisions on how to use background data to achieve cleanup levels or applicable or relevant and appropriate requirements (ARARs).*" Rather, the discussion defines background levels as the function of local, regional, or global anthropogenic sources plus naturally occurring levels. Therefore, they are distinct from onsite concentrations that include the anthropogenic and natural sources plus concentrations resulting from site-related activities. The statistical guidance cited specific to groundwater contains references to standard statistical methods recognized by the Agency. Methods included in the documentation are equally applicable to any environmental matrix and cover the methods described and applied in Sections 3 and 4.

3.0 General Approach

Several methods are available to statistically test for differences between background and site-related concentrations. Population-to-population tests can explicitly compare concentrations from onsite samples to background samples. Methods include t-tests, which compare two means and, where data do not follow theoretical, assumed distributions for the parametric test, the nonparametric analogues (either the Mann-Whitney test or the rank sum test).

Alternatives that routinely are used in both soil and groundwater comparisons include calculating an upper limit from the background sample results, against which onsite concentrations are compared. Exceedance of the upper limit of the background levels by onsite concentrations is taken to indicate that onsite levels are elevated beyond what is expected to represent background conditions.

The statistical tools used in such comparisons include percentile estimates, upper tolerance limits (UTLs), and prediction limits. Percentile estimates involve estimating some proportion of the background population, such as the 95th or 99th percentile, which corresponds to the concentration that is greater than or equal to 95 or 99 percent of background observations. UTLs are similar but have the added advantage of an uncertainty interval about the percentile, such as the 95th confidence interval on the 95th percentile of background levels. Prediction intervals are similar to UTLs but are intervals within which the next pre-specified number of observations should fall within, such as the

95th percent confidence interval on the next seven observations from a population that is represented by background levels.

For purposes of the evaluation of background levels of inorganics concentrations in ABL soils, UTLs have been derived from areas on the facility where no prior site activities have been documented. The UTLs define the upper 95th confidence interval on the 95th percentile of background soil concentrations of inorganics. This level is "conservative" in that it would be expected that approximately the highest 5 percent of values in true background would be found questionable (e.g., anomalously high) in comparison to the limit. In contrast, a prior methodology (CH2M HILL, October 1996) calculated background upper confidence limits (UCLs) on the mean concentration. This estimate then was compared to the maximum concentration observed and the highest value was selected. UTL calculation is a more straightforward application of methods of comparing site to background levels because the statistics relate to the actual concentrations rather than to a derived value (i.e., the mean).

UTLs are calculated in different ways, each appropriate to the distribution assumed. Where data are normally distributed, the normal estimates are appropriate. If data are not normally distributed, but, rather, lognormally distributed, the more appropriate calculation is based upon lognormal estimates. If neither theoretical distribution is followed by the observations, a nonparametric method is preferred. In the evaluation that is the subject of this TM, observations were tested in terms of the normal theoretical distributions using the Shapiro-Wilk test. If the observations followed a normal theoretical distribution, the appropriate calculation method for the normal distribution was used. Where observations did not follow the normal distribution, nonparametric methods, which are based upon rank (or order) statistics and assume no theoretical distribution, were applied.

The lognormal theoretical distribution was not evaluated because the data sets were too small to generate meaningful results. While distributional tests for lognormality can be run with samples sizes as small as those for the present evaluation, the estimates of the mean and, in particular, the variance, which are the critical quantities in estimating the upper bounds, are not accurate when sample sizes are less than 20 to 25 samples. The reasons are that the lognormal is a skewed distribution and the rare concentrations on the upper end of the limit have a much-lower probability of being captured when sample sizes are small. Consequently, estimates of central tendency may be adversely affected, but upper bounds, such as the upper 95th tolerance interval, are extremely sensitive, making calculated UTLs for the lognormal distribution often exceed far beyond the maximum observation reported.

The limitation to the nonparametric methods is the coverage or confidence that can be achieved with calculation of the 95 percent UTL, given the sample sizes. For sample sizes of 9, 8, 5, and 4 observations, corresponding confidence with the maximum value as representing the upper 95th percentile of the distribution are 72, 69, 55 and 47 percent, respectively. This is strictly the function of the limited sample sizes. Clearly, the level of confidence in the results decreases as the sample size decreases.

The presence or absence of a theoretical distribution to the results determined the background concentration obtained from the results. The UTL for the normal distribution was calculated using the appropriate statistical package and represents the calculated 95 percent upper confidence limit on the 95th UTL, while the UTL for the nonparametric cases

is selected as the maximum concentration detected. For cases where there were no detections of an analyte, the mean of one-half of each quantitation limit was used.

4.0 Statistical Methods

Statistical methods used to describe and characterize the available background data from soil on the facility include relative percent difference (RPD), frequency of detection (FD), boxplots, and the Shapiro-Wilk goodness-of-fit test. Each of these methods is briefly described below. The statistics in the evaluation of ABL background inorganics were calculated using SYSTAT, distributed by SPSS of Evanston, Illinois; and S-plus and EnvironmentalStats for S-plus, distributed by Insightful of Seattle, Washington.

Relative Percent Difference

RPD is the ratio of the difference between two observations, standardized by the mean of the same two observations. The RPD between two samples that differ in reported concentration by a fixed amount can differ widely, depending upon the concentration range of the results. For example, the RPD for a 100-milligram per kilogram (mg/kg) difference between a surface sample reported at 10 mg/kg and a subsurface sample reported at 110 mg/kg is -167 percent. The same 100-mg/kg difference between reported surface and subsurface concentrations of 1,100 mg/kg and 1,000 mg/kg, respectively, results in a calculated RPD of only +9.5 percent.

Frequency of Detection

The FD is the percentage of observations that have been reported by the analytical laboratory as detectable concentrations. FD is a rough indicator of distribution, in that FDs that are less than 80 percent (0.80) are unlikely to exhibit either a normal or lognormal distribution. FDs less than 50 percent (0.5) indicate extremely rare detections that are at the limits of analytical methods used in quantification.

Boxplots

Boxplots are statistical graphics that allow visual comparison of different data subsets. Boxplots of different data subsets that overlap completely indicate that samples represented in the different subsets likely are drawn from a common population. Boxes with marginal overlap indicate that subsets could well represent different populations. Boxplot displays presented throughout this document have been supplemented with an overlay of dot density, which plots each individual point in the data subset. With the overlay, the exact count of observations represented in the boxplot can be verified.

The boxplots were reviewed and evaluated for the occurrence of potential outliers. An outlier is a reported observation that is anomalous enough to be considered unrepresentative of the population sampled. However, identifying outliers is a difficult process, as infrequent or rare concentrations would be expected to occur occasionally even when sampling a single population because, even in areas for which there is no documented contamination process, natural variability may produce such high concentrations. Eliminating rare concentrations that are particularly high or low may artificially truncate the distribution of the true population, potentially biasing estimates and underestimating true parameter variability.

Shapiro-Wilk Goodness-of-Fit Test

GOF tests compare the distribution of observed values to known, theoretical distributions. The Shapiro-Wilk GOF (SW GOF) test, appropriate for sample sizes less than or equal to 50, was applied to observations on the 23 parameters for subsurface soil and 24 parameters for surface soil quantified in background soil. The test score from the SW GOF test corresponds to a probability of the occurrence of that theoretical distribution, relative to the number of observations. Probabilities less than 0.05 are considered evidence that the observed values deviate substantively from the tested theoretical distribution. In the TM, SW GOF tests for normality were performed using untransformed values. If the results exceeded 0.05, the normal distribution was assumed and percentile calculations were applied accordingly. If the result was less than 0.05, UTLs were estimated using nonparametric methods.

5.0 Available Data

Background soil samples were collected from surface depths (0 to 1 foot below ground surface [bgs]) and subsurface depths (2 feet bgs, 2 to 4 feet bgs, 4 feet bgs, and 4 to 6 feet bgs). The original data file of inorganics concentrations from ABL background locations consisted of 835 records. When the data file was examined, some preliminary data-management procedures were applied to document internal consistency and acceptability of the reported results and to consolidate quality assurance/quality control (QA/QC) samples into single estimates.

The available data and the data-management procedures applied are summarized below:

- Per discussions between the Navy and the regulators, several samples were removed from the original dataset. These samples were all of those collected at Site 5 and Solid Waste Management Units (SWMUs) 22A and 22C and the surface samples from SWMUs 10006A and 10006B. The assumption is that the remaining results are from soil samples that were collected from areas on the facility where no prior site activities have resulted in a release to the environment. The designations of the samples used in the analysis are listed in Table 1, along with a designation as to whether they are surface or subsurface soil and from where the samples were obtained.

- The adjusted analytical results for each sample are provided in Table 2. By "adjusted" it is meant that: 1) the table contains the average of the original sample and its duplicate for samples HCS-BR-2 and 23-2-T, and 2) results that were below the quantitation limit are listed in the table at one-half the quantitation limit.

- Data were quantified in units of mg/kg. Data qualifiers originally comprised 12 unique codes, which referred to various qualifiers for such factors as blank contamination and values estimated less than the quantitation limit. The original qualifiers were coded into three categories: detected (D), not detected (U), and rejected (R). All results qualified as being estimated below the quantitation limit (i.e., those with a J flag specified by the data validator) were qualified with a D. All results qualified as containing contamination also detected in a blank sample (i.e., those with a B flag specified by the data validator) were qualified with a U. A multiplier was applied to each reported concentration, depending upon the qualifier. Detects were multiplied by

1 and nondetects (i.e., those below the quantitation limits) were multiplied by 0.5. Rejected values were multiplied by 0 and then removed from the data file.

- Two surface samples were duplicated: HCS-BR-2/-2DUP and 23-2-T/-TDUP. Table A-1 in Appendix A includes the raw data for both samples. The table lists the two values for the pair (when available) as well as the mean and RPD. Table A-2 summarizes individual RPDs by parameter, listing the minimum, maximum, and mean RPD. Note that the values of those analytes not detected are listed as one-half the quantitation limit.

  In an ideal world, RPDs would cover approximately the same range of positive and negative values and average zero. While some parameters exhibit comparatively high average RPDs, the sample size is limited (i.e., there were only two samples with duplicates). Additionally, none of the minimum or maximum values is so extreme as to indicate a problem with the data. Therefore, the duplicate measures were replaced with a single result (the mean value of the two analyses). Doing so prevents artificial weighting of the duplicate location due to QA/QC sampling that would occur if both the original sample and its duplicate were used in the data set.

- Parameters quantified from the soil samples comprised 23 metals from subsurface soils: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), calcium (Ca), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), mercury (Hg), nickel (Ni), potassium (K), selenium (Se), silver (Ag), sodium (Na), thallium (Tl), vanadium (V), and zinc (Zn). Surface soils were quantified for the same parameters plus cyanide (CN), for a total of 24 parameters.

- The qualitative distributions of the results were evaluated using boxplots. Appendix B compares the surface-soil results (24 analytes) and the subsurface soil results (23 analytes) for each analyte. The plots have been transformed to a log scale to more clearly exhibit the distributions of observations. The first figure in Appendix B is a generic boxplot that defines each of the components of the plot and includes a brief explanation of boxplot interpretation. Table B-1, located at the end of Appendix B, contains the results of applying a nonparametric comparison of surface and subsurface data to determine whether the results were obtained from two different populations. The results of this evaluation are presented in Section 6.0.

- Tables 3, 4, and 5 summarize statistical results from surface samples, subsurface samples, and pooled surface and subsurface samples by parameter. The tables contain the parameter name; the count of detected observations and total observations; the FD; the minimum and maximum of reported nondetects (if any) and of reported detects; and the mean and standard deviation for the observations (where nondetects have been treated at one-half the quantitation limit). Cyanide, sodium, and thallium were not detected in any surface samples. FDs for the remaining 21 parameters in surface soil ranged between 11 and 100 percent. Mercury and sodium were not detected in subsurface samples. FDs for the remaining 21 parameters in subsurface soil ranged between 15 and 100 percent.

- Where FDs are 0 (i.e., for cyanide, sodium, and thallium in surface soil and mercury and sodium in subsurface soil), a meaningful background UTL cannot be calculated. Rather, such a calculated value would be a statement about analytical sensitivity (i.e., about

quantitation limits) rather than about the true distribution of parameter concentrations in background soils. In such cases, calculating the mean reported nondetect based on one-half of the quantitation limit provided a more-conservative estimate. An exceedance of the mean of one-half the quantitation limits would indicate that the onsite concentrations exceed what would be expected in true background locations.

6.0 Preliminary Evaluations

This section summarizes results from the evaluations of potential outliers and parameter distribution testing.

Surface vs. Subsurface Results

Based on the box plots (Appendix B) and the results of the nonparametric comparison (Table B-1 in Appendix B), the surface results for only seven analytes differed significantly from the subsurface results: aluminum, antimony, beryllium, chromium, copper, iron, and magnesium. For these analytes, the surface soil and subsurface soil samples were treated as if they were from separate populations. For the remaining analytes, the surface and subsurface results were pooled for the statistical analysis. An exception was cyanide, which was analyzed for only in the surface-soil samples. Each group of analytical results (i.e., for surface soil, subsurface soil, and pooled surface and subsurface soil) are analyzed statistically as separate groups.

Potential Outliers

Based on examining the boxplots (Appendix B), the concentrations of a few parameters from some samples appear to be unusually high compared to other samples. Calcium, magnesium, mercury, and selenium in surface soil and calcium and silver in subsurface soil exhibit elevated levels in some samples compared to the general ranges of concentrations of these analytes. However, these high values were not removed from the data set because there was no justification based on the sampling locations, depths, or other considerations. An exception was the data set obtained from Site 5, which was *a priori* considered a potentially impacted area. Consequently, independent of exploratory results, it was determined that calculations would be performed without Site 5 data.

Distribution Testing

SW GOF testing of the analytical results yielded graphical displays of the GOF of normal distributions to available surface and subsurface data. The graphical displays and supporting data are shown in Appendix C. Each of the figures includes four panels, described as follows:

- The upper-left figure is a frequency distribution of the observations, plotting relative frequency across concentration. The frequency distribution is useful in identifying relative abundance of observations over the range of concentrations within the subset.
- The lower-left plot is a quantile-quantile plot of a theoretical normal distribution on the x-axis plotted against the quantiles of the observed values on the y-axis. Points lying on the diagonal indicates adherence to the theoretical normal distribution (i.e., the quantiles of theoretical and observed values coincide).

- The upper-right panel is a display of the cumulative density function of the observations (defining the solid line) against the theoretical distribution being tested (defining the dashed line). The more closely the observations follow the theoretical distribution, the closer are the lines.
- The lower-right panel documents results of the SW GOF test, indicating the distribution being tested and the probability value of the test statistic (given the degrees of freedom of the observations). By convention, probability values exceeding a cutpoint (typically 0.05 or 0.10) indicate that the value of the W-statistic is common enough to accept the null hypothesis of the observations following the theoretical distribution tested. In other words, if the probability statistic (i.e., the P-value) exceeds 0.05, then the distribution is assumed to be normal. If the statistic is less than 0.05, then the data are assumed to be nonparametric.

The results from the GOF testing for the surface and subsurface inorganics parameters, indicating which analytes are normally distributed and which are nonparametric, are provided in tables 6, 7, and 8, respectively. Tables 6, 7, and 8 include the name of the analyte, the number of analyses (i.e., the sample size), the FD, the maximum concentration, the probability value for the SW GOF test from the displays in Appendix C (in column 5), and the determination as to whether the UTLs are to be calculated using normal distribution (NUTL) or nonparametric methods (NPUTL) (in column 6). Note that the sample size differs between parameters (e.g., cyanide in Table 6) because some analyses were rejected.

7.0 Background Soil Concentrations

Tables 6, 7, and 8 contain the estimated background concentrations for surface soil, subsurface soil, and pooled surface and subsurface soil, respectively. In addition to the results of the SW GOF testing (described above), the three tables contain the UTLs based on either a normal distribution or nonparametric methods (columns 7 and 8, respectively) and the estimation approach assumed for percentile calculations (either a UTL for the normal distribution or nonparametric methods or the mean of one-half of each quantitation limit) (column 9).

Column 10 lists the estimated background concentration. The UTL for the normal distribution was calculated using the appropriate statistical package and represents the calculated 95 percent upper confidence limit on the 95th UTL, while the UTL for the nonparametric cases is selected as the maximum concentration detected. For cases where there were no detections of an analyte, the mean of one-half of each quantitation limit was used.

In the case of nonparametric estimates, the UTL also is 95 percent but the confidence in the UTL is limited by the number of observations. If sample sizes were on the order of 60 observations, the maximum value would represent approximately 95 percent confidence on the 95th. However, where sample sizes are on the order of 9 to 22 (as in the case of the analysis of the ABL soil background), confidence is limited to 57 percent or 58 percent for the pooled results (last column in Table 8), 72 percent for surface soil (last column in Table 6) and 79 percent for subsurface soil (last column in Table 7). Although these results

probably underestimate the true upper bound of the background concentrations, lower UTL estimates are a trade off for accepting smaller sample sizes.

Reviewing tables 6, 7 and 8 shows that there are cases where the estimator for the background concentration of an analyte exceeds the maximum value of the analyte detected. This always occurs in the analysis of ABL background soil when the UTL is calculated using the normal distribution. It should be kept in mind that calculated tolerance limits contain a certain percentage (in this case, 95 percent) of the population of future measurements with a certain level of confidence (in this case, 95 percent). Given the small number of samples available for the analysis, it is reasonable to assume that there may be some values of background that could be found that would exceed the maximum observed concentrations. It is the advantage of a theoretical distribution (assuming that the observations follow it) that one can extrapolate beyond the range of the observations. The fact that the UTL calculated using the normal distribution (and the estimates of the mean and variance of the parameter concentrations) exceeds the maximum value accounts for the possibility that some background values may exceed the maximum. Therefore, when the UTL exceeds the maximum concentration of a particular data set, it represents a reasonable estimate of the highest expected concentration of the analyte with 95 percent confidence. Note, however, that when the estimated background concentration exceeds the maximum concentration it is only by a few percent.

8.0 References

CH2M HILL. October 1996. *Preliminary Remediation Goals for Site 1 Soil and Establishment of Background Concentrations.* Prepared for LANTDIV by CH2M HILL.

USEPA. April 1989. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance.* USEPA Publication EPA/530-SW-89-026.

USEPA. April 1992. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance.* USEPA Publication EPA/539-R-93-003.

USEPA. December 1995. *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites.* USEPA Engineering Forum Issue Paper, EPA/540/S-96/500).

Table 1
Surface-Sample and Subsurface-Sample Identifiers
ABL Soil-Background Evaluation for Inorganics

Sample Identifier	Location	Number of Analytes
Surface Soil		
HCS-BR-1	Background	24
HCS-BR-2	Background	24
HCS-BR-2DUP*	Background	24
HCS-BR-3	Background	24
HCS-BR-4	Background	24
23-1-T	SWMU 23	23
23-2-T	SWMU 23	23
23-2-T/DUP*	SWMU 23	23
23-4-T	SWMU 23	23
HCS-PWA-29S	Site 10	23
SITE3-1-T	Site 3	23
Subsurface Soil		
10006A-1-D	AOC 10006	23
10006A-2-D	AOC 10006	23
10006A-3-D	AOC 10006	23
10006B-1-D	AOC 10006	23
10006B-2-D	AOC 10006	23
10006B-3-D	AOC 10006	23
26-1-D	SWMU 26	23
26-2-D	SWMU 26	23
37D-1-D	SWMU 37D	23
37T-1-D	SWMU 37T	23
HCS-PWA-29	Site 10	23
HCS-S2-5	Site 2	23
HCS-S2-6	Site 2	23

Note:
* Duplicate of the preceding sample

Table 2

Adjusted[1] Analytical Results Used in the Statistical Analysis

ABL Soil-Background Evaluation for Inorganics

Sample Identifier	Aluminum		Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q
Surface Soil												
HCS-BR-1	8920	D	9.9	D	8.2	D	47.6	D	0.38	U	1.20	D
HCS-BR-3	9500	D	ND		6.2	D	102.0	D	0.39	U	0.55	U
HCS-BR-4	8110	D	ND		6.2	D	110.0	D	0.36	U	0.36	U
HCS-BR-2	5295	D	17.5	D	6.3	D	91.6	D	0.65	D	0.32	U
23-1-T	1940	D	11.0	D	1.7	D	5.8	U	0.08	U	2.40	D
SITE3-1-T	10100	D	4.6	U	7.6	D	78.4	D	0.40	U	0.33	U
HCS-PWA-29S	9040	D	3.8	U	6.5	D	120.0	D	1.20	D	1.15	U
23-4-T	1850	D	ND		1.8	D	9.4	U	0.08	U	0.25	U
23-2-T	11250	D	ND		11.5	D	76.9	D	0.43	U	0.28	U
Subsurface Soil												
10006A-1-D	13600	D	4.7	U	7.3	D	61.0	D	0.55	U	0.34	U
10006A-2-D	22500	D	4.6	U	11.7	D	102.0	D	1.40	D	0.33	U
10006A-3-D	20900	D	4.9	U	5.1	D	104.0	D	1.50	D	0.35	U
10006B-1-D	12500	D	4.2	U	8.5	D	49.2	D	0.44	U	0.30	U
10006B-2-D	11000	D	4.3	U	9.3	D	43.3	D	0.44	U	0.31	U
10006B-3-D	12400	D	3.8	U	9.5	D	49.8	D	1.00	D	0.27	U
26-1-D	11800	D	4.6	U	6.9	D	106.0	D	0.47	U	0.43	U
26-2-D	11900	D	4.3	U	8.5	D	69.0	D	0.43	U	0.31	U
37D-1-D	11700	D	3.8	U	4.8	D	77.4	D	0.90	D	0.32	U
37T-1-D	15800	D	4.2	U	9.5	D	154.0	D	1.40	D	0.29	U
HCS-PWA-29	8540	D	3.5	U	13.1	D	159.0	D	1.30	D	2.30	D
HCS-S2-5	8220	D	2.9	D	5.0	D	220.0	D	1.20	D	1.00	D
HCS-S2-6	9800	D	3.0	D	6.7	D	205.0	D	1.20	D	0.95	D

Table 2

Adjusted[1] Analytical Results Used in the Statistical Analysis

ABL Soil-Background Evaluation for Inorganics

Sample Identifier	Calcium		Chromium		Cobalt		Copper		Cyanide		Iron	
	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q
Surface Soil												
HCS-BR-1	37600	D	11.9	D	10.6	D	15.7	D	0.60	U	19900	D
HCS-BR-3	5830	D	14.2	D	5.3	U	24.4	D	0.70	U	23900	D
HCS-BR-4	4520	D	12.9	D	5.8	U	18.6	D	0.65	U	23000	D
HCS-BR-2	16670	D	9.6	D	16.6	D	17.6	D	0.63	U	20200	D
23-1-T	292000	D	3.2	D	0.6	U	7.5	D	ND		4160	D
SITE3-1-T	17500	D	14.1	D	13.5	D	23.2	D	ND		28700	D
HCS-PWA-29S	5380	D	13.4	D	12.9	D	18.1	D	ND		27200	D
23-4-T	273000	D	2.8	D	0.8	U	16.7	D	ND		4720	D
23-2-T	40200	D	14.3	D	21.9	D	18.8	D	ND		25750	D
Subsurface Soil												
10006A-1-D	3690	D	16.4	D	11.4	D	29.4	D	NA		34900	D
10006A-2-D	4780	D	23.8	D	4.3	U	31.3	D	NA		17500	D
10006A-3-D	5500	D	18.5	D	15.4	D	22.0	D	NA		24400	D
10006B-1-D	67000	D	12.6	D	7.2	D	19.6	D	NA		28300	D
10006B-2-D	19000	D	12.6	D	11.2	D	20.9	D	NA		29400	D
10006B-3-D	9600	D	13.7	D	15.0	D	24.5	D	NA		33500	D
26-1-D	56700	D	16.4	D	12.1	D	21.4	D	NA		25700	D
26-2-D	6290	D	16.1	D	14.9	D	25.9	D	NA		33400	D
37D-1-D	5890	D	16.9	D	12.5	D	21.4	D	NA		29100	D
37T-1-D	3850	D	24.0	D	11.8	D	23.3	D	NA		36000	D
HCS-PWA-29	2990	D	12.3	D	15.3	D	22.3	D	NA		41300	D
HCS-S2-5	2540	D	13.8	D	17.1	D	26.2	D	NA		27500	D
HCS-S2-6	2580	D	15.7	D	19.0	D	31.6	D	NA		31800	D

Table 2

Adjusted[1] Analytical Results Used in the Statistical Analysis

ABL Soil-Background Evaluation for Inorganics

Sample Identifier	Lead		Magnesium		Manganese		Mercury		Nickel		Potassium	
	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q
Surface Soil												
HCS-BR-1	38.8	D	5180	D	257	D	0.040	U	24.6	D	1850	D
HCS-BR-3	37.7	D	2460	D	504	D	0.040	U	16.8	D	1700	D
HCS-BR-4	39.8	D	1970	D	792	D	0.050	U	23.6	D	1810	D
HCS-BR-2	29.2	D	2485	D	607	D	0.170	D	27.6	D	838	D
23-1-T	6.6	D	12800	D	78	D	0.030	U	4.0	D	247	U
SITE3-1-T	41.5	D	3200	D	726	D	0.025	U	23.8	D	1610	D
HCS-PWA-29S	22.0	D	1560	D	1070	D	0.030	U	16.4	D	545	U
23-4-T	9.6	D	14100	D	107	D	0.035	U	4.3	D	230	U
23-2-T	16.9	D	3665	D	546	D	0.043	U	15.5	D	1009	D
Subsurface Soil												
10006A-1-D	13.5	D	2390	D	251	D	0.030	U	20.1	D	1510	D
10006A-2-D	12.6	D	2190	D	76	D	0.030	U	20.4	D	1590	D
10006A-3-D	15.0	D	2730	D	168	D	0.025	U	24.4	D	1780	D
10006B-1-D	10.5	D	2090	D	107	D	0.025	U	16.8	D	1590	D
10006B-2-D	9.6	D	2190	D	251	D	0.025	U	20.7	D	1610	D
10006B-3-D	12.1	D	2310	D	417	D	0.025	U	23.7	D	1820	D
26-1-D	17.8	D	2300	D	1240	D	0.030	U	20.2	D	1880	D
26-2-D	14.0	D	2410	D	474	D	0.030	U	23.3	D	1590	D
37D-1-D	14.6	D	2350	D	565	D	0.025	U	19.5	D	1190	D
37T-1-D	18.9	D	2230	D	551	D	0.025	U	24.4	D	1510	D
HCS-PWA-29	18.8	D	1610	D	1200	D	0.050	U	26.3	D	454	U
HCS-S2-5	17.1	D	1190	D	1170	D	0.040	U	23.2	D	1120	D
HCS-S2-6	23.2	D	1420	D	1140	D	0.045	U	27.0	D	1170	D

Table 2

Adjusted[1] Analytical Results Used in the Statistical Analysis

ABL Soil-Background Evaluation for Inorganics

Sample Identifier	Selenium		Silver		Sodium		Thallium		Vanadium		Zinc	
	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q	Concentration	Q
Surface Soil												
HCS-BR-1	2.40	D	0.50	U	34.0	U	0.40	U	24.3	D	98.2	D
HCS-BR-3	0.49	U	2.00	D	23.0	U	0.49	U	25.2	D	71.6	D
HCS-BR-4	0.48	U	0.60	U	16.9	U	0.48	U	25.5	D	77.8	D
HCS-BR-2	0.67	D	0.90	D	59.1	U	0.43	U	19.2	D	106.5	D
23-1-T	0.25	U	0.33	U	59.0	U	0.25	U	2.2	U	24.6	D
SITE3-1-T	0.33	U	0.55	U	30.7	U	1.00	U	15.5	D	49.9	D
HCS-PWA-29S	0.43	U	ND		12.8	U	0.35	U	23.9	D	62.2	D
23-4-T	0.25	U	0.33	U	56.5	U	0.25	U	2.6	U	56.4	D
23-2-T	0.28	U	0.52	U	33.9	U	0.28	U	20.2	D	46.4	D
Subsurface Soil												
10006A-1-D	0.34	U	0.45	U	17.1	U	2.90	D	18.2	D	39.4	D
10006A-2-D	0.33	U	0.44	U	37.6	U	1.50	D	33.4	D	42.7	D
10006A-3-D	0.35	U	0.47	U	46.8	U	2.50	D	18.7	D	35.8	D
10006B-1-D	0.30	U	0.40	U	40.3	U	1.80	D	14.4	D	27.9	D
10006B-2-D	0.31	U	0.41	U	28.5	U	1.80	D	13.1	D	28.1	D
10006B-3-D	0.27	U	0.39	U	32.0	U	2.40	D	15.7	D	33.5	D
26-1-D	0.33	U	0.44	U	58.5	U	0.33	U	21.2	D	63.8	D
26-2-D	0.31	U	0.41	U	29.6	U	0.31	U	18.4	D	43.3	D
37D-1-D	0.26	U	0.40	U	31.0	U	2.30	D	18.6	D	40.1	D
37T-1-D	0.29	U	0.50	U	20.9	U	2.90	D	32.2	D	75.8	D
HCS-PWA-29	0.22	U	2.10	D	23.3	U	0.33	U	26.3	D	87.0	D
HCS-S2-5	0.48	D	0.17	U	97.5	U	0.24	U	19.2	D	80.3	D
HCS-S2-6	0.45	D	0.48	D	104.5	U	0.25	U	21.8	D	84.3	D

Table 2

Adjusted[1] Analytical Results Used in the Statistical Analysis

ABL Soil-Background Evaluation for Inorganics

Notes:

[1] The results have been adjusted to include one-half the detection limit for non-detected analytes and the average result for sample HCS-BR2 and its duplicate and for sample 23-2-T and its duplicate.

Q = Data-validation qualifier

D - Detected at the indicated concentration

U = Not detected; concentration is one-half of the quantitation limit

All units are milligrams per kilogram

ND = No data available

NA = Not analyzed for

Table 3

Statistical Summary by Analyte for Surface-Soil Results

ABL Soil-Background Evaluation for Inorganics

Analyte	Number of Detections	Number of Analyses	Frequency of Detection	Nondetections		Detections		Mean	Standard Deviation
				Minimum	Maximum	Minimum	Maximum		
Aluminum	9	9	1.00			1850	11250	7334	3483
Antimony	3	5	0.60	3.80	4.60	9.90	17.5	9.36	5.54
Beryllium	2	9	0.22	0.080	0.43	0.65	1.20	0.44	0.33
Chromium	9	9	1.00			2.80	14.3	10.7	4.61
Copper	9	9	1.00			7.50	24.4	17.8	4.82
Cyanide	0	4	0.00	0.60	0.70			0.65	0.043
Iron	9	9	1.00			4160	28700	19726	9142
Magnesium	9	9	1.00			1560	14100	5269	4768

Notes:

All units are in milligrams per kilogram

Blank space indicates no results in that range (either nondetection or detection)

Table 4

Statistical Summary by Analyte for Subsurface-Soil Results

ABL Soil-Background Evaluation for Inorganics

Analyte	Number of Detections	Number of Analyses	Frequency of Detection	Nondetections		Detections		Mean	Standard Deviation
				Minimu m	Maximu m	Minimu m	Maximu m		
Aluminum	13	13	1.00			8220	22500	13128	4307
Antimony	2	13	0.15	3.55	4.90	2.90	3.00	2.26	0.37
Beryllium	8	13	0.62	0.43	0.55	0.90	1.50	0.85	0.53
Chromium	13	13	1.00			12.3	24.0	16.4	3.85
Copper	13	13	1.00			19.6	31.6	24.6	4.02
Iron	13	13	1.00			17500	41300	30215	5990
Magnesium	13	13	1.00			1190	2730	2108	437

Note:

All units are in milligrams per kilogram

Blank space indicates no results in that range (either nondetection or detection)

Table 5

Statistical Summary by Analyte for Pooled Surface-Soil and Subsurface-Soil Results

ABL Soil-Background Evaluation for Inorganics

Analyte	Number of Detections	Number of Analyses	Frequency of Detection	Nondetections		Detections		Mean	Standard Deviation
				Minimum	Maximum	Minimum	Maximum		
Arsenic	22	22	1.00			1.70	13.1	7.36	2.85
Barium	20	22	0.91	5.85	9.35	43.3	220	92.8	55.0
Cadmium	5	22	0.23	0.25	1.15	0.95	2.40	0.65	0.63
Calcium	22	22	1.00			2540	292000	40141	80586
Cobalt	17	22	0.77	0.60	5.80	7.20	22.0	11.6	5.60
Lead	22	22	1.00			6.60	41.5	20.0	10.6
Manganese	22	22	1.00			76.2	1240	559	395
Mercury	1	22	0.05	0.025	0.055	0.17	0.17	0.039	0.030
Nickel	22	22	1.00			4.00	27.0	20.3	6.26
Potassium	18	22	0.82	230	545	838	1880	1302	534
Selenium	4	22	0.18	0.22	0.49	0.45	2.40	0.45	0.45
Silver	4	21	0.19	0.17	0.60	0.48	2.10	0.61	0.50
Sodium	0	22	0.00	12.8	105.0			40.6	24.0
Thallium	8	22	0.36	0.24	1.00	1.50	2.90	1.07	0.98
Vanadium	20	22	0.91	2.20	2.60	13.1	33.4	19.5	7.58
Zinc	22	22	1.00			24.6	107	58.0	24.2

Note:

All units are in milligrams per kilogram

Blank space indicates no results in that range (either nondetection or detection)

Table 6

Goodness-of-Fit Testing and Background Values for Selected Analytes in Surface Soil

ABL Soil-Background Evaluation for Inorganics

Analyte	Number of Analyses	Frequency of Detection	Maximum Concentration (mg/kg)	Shapiro-Wilk Test Result		UTL Estimate		Estimator	Background Concentration (mg/kg)	Confidence Limit
				~N	Statitistical Distribution	Normal Distribution	Nonparametric			
Aluminum	9	1.0	11250	0.081	N	17891	11250	NUTL	17891	0.95
Antimony	5	0.60	17.5	0.55	N	33	17.5	NUTL	33	0.95
Beryllium	9	0.22	1.2	0.038	NP	1.5	1.2	NPUTL	1.2	0.72
Chromium	9	1.0	14.3	0.0064	NP	25	14.3	NPUTL	14.3	0.72
Copper	9	1.0	24.4	0.21	N	32	24.4	NUTL	32	0.95
Cyanide	4	0	0.7	0.85	N	NA	NA	Mean U	0.65	0.95
Iron	9	1.0	28700	0.025	NP	47436	28700	NPUTL	28700	0.72
Magnesium	9	1.0	14100	0.0034	NP	19721	14100	NPUTL	14100	0.72

Notes:

mg/kg = milligrams per kilogram

~N = Probability value for the test statistic (less than 0.05 indicates nonparametric and greater than 0.05 indicates normal)

N = Normal distribution

NP = Nonparametric

NUTL = Normal-distribution upper tolerance limit

NPUTL = Nonparametric upper tolerance limit

NA = Not applicable (i.e., no UTL estimate for analytes with no detections)

Mean U = Mean of one-half the quantitation limit

Table 7

Goodness-of-Fit Testing and Background Values for Selected Analytes in Subsurface Soil

ABL Soil-Background Evaluation for Inorganics

Analyte	Number of Analyses	Frequency of Detection	Maximum Concentration (mg/kg)	Shapiro-Wilk Test Result		UTL Estimate		Estimator	Background Concentration (mg/kg)	Confidence Limit
				~N	Statistical Distribution	Normal Distribution	Nonparametric			
Aluminum	13	1.00	22500	0.030	NP	24629	22500	NPUTL	22500	0.79
Antimony	13	0.15	3.0	0.33	N	5.7	3.00	NUTL	5.7	0.95
Beryllium	13	0.62	1.5	0.037	NP	2.1	1.5	NPUTL	1.5	0.79
Chromium	13	1.00	24.0	0.028	NP	26.6	24.0	NPUTL	24.0	0.79
Copper	13	1.00	31.6	0.12	N	35.3	31.6	NUTL	35.3	0.95
Iron	13	1.00	41300	0.99	N	46212	41300	NUTL	46212	0.95
Magnesium	13	1.00	2730	0.044	NP	3274	2730	NPUTL	2730	0.79

Notes:

mg/kg = milligrams per kilogram

~N = Probability value for the test statistic (less than 0.05 indicates nonparametric and greater than 0.05 indicates normal)

N = Normal distribution

NP = Nonparametric

NUTL = Normal-distribution upper tolerance limit

NPUTL = Nonparametric upper tolerance limit

Mean U = Mean of one-half the quantitation limit

Table 8

Goodness-of-Fit Testing and Background Values for Selected Analytes in Combined Surface and Subsurface Soil

ABL Soil-Background Evaluation for Inorganics

Analyte	Number of Analyses	Frequency of Detection	Maximum Concentration (mg/kg)	Shapiro-Wilk Test Result		UTL Estimate		Estimator	Background Concentration (mg/kg)	Confidence Limit
				~N	Statistical Distribution	Normal Distribution	Nonparametric			
Arsenic	22	1.00	13.1	0.70	N	14.5	13.1	NUTL	14.5	0.95
Barium	20	0.91	220	0.22	N	231	220	NUTL	231	0.95
Cadmium	5	0.23	2.4	10 E-6	NP	2.23	2.4	NPUTL	2.40	0.58
Calcium	22	1.00	292000	10 E-7	NP	242848	292000	NPUTL	292000	0.58
Cobalt	17	0.77	22.0	0.42	N	25.7	22.0	NUTL	25.7	0.95
Lead	22	1.00	41.5	0.004	NP	46.80	41.5	NPUTL	41.5	0.58
Manganese	22	1.00	1240	0.03	NP	1551	1240	NPUTL	1240	0.58
Mercury	1	0.05	0.17	10 E-8	NP	0.12	0.17	NPUTL	0.17	0.58
Nickel	22	1.00	27.0	0.001	NP	36.1	27.6	NPUTL	27.6	0.58
Potassium	18	0.82	1880	0.006	NP	2646	1880	NPUTL	1880	0.58
Selenium	4	0.18	2.40	10 E-8	NP	1.58	2.40	NPUTL	2.40	0.58
Silver	4	0.19	2.1	10 E-7	NP	1.87	2.1	NPUTL	2.1	0.57
Sodium	0	0.00	105	0.003	NP	NA	NA	Mean U	105	0.58
Thallium	8	0.36	2.9	10 E-4	NP	3.54	2.9	NPUTL	2.9	0.58
Vanadium	20	0.91	33.4	0.13	N	38.6	33.4	NUTL	38.6	0.95
Zinc	22	1.00	107	0.25	N	119	107	NUTL	119	0.95

Notes:
mg/kg = milligrams per kilogram
~N = Probability value for the test statistic (less than 0.05 indicates nonparametric and greater than 0.05 indicates normal)
N = Normal distribution
NP = Nonparametric
NUTL = Normal-distribution upper tolerance limit
NPUTL = Nonparametric upper tolerance limit
NA = Not applicable (i.e., no UTL estimate for analytes with no detections)
Mean U = Mean of one-half the quantitation limit

Appendix A
Duplicate Evaluation

Table A-1
Duplicate Sample Results
ABL Soil-Background Evaluation for Inorganics

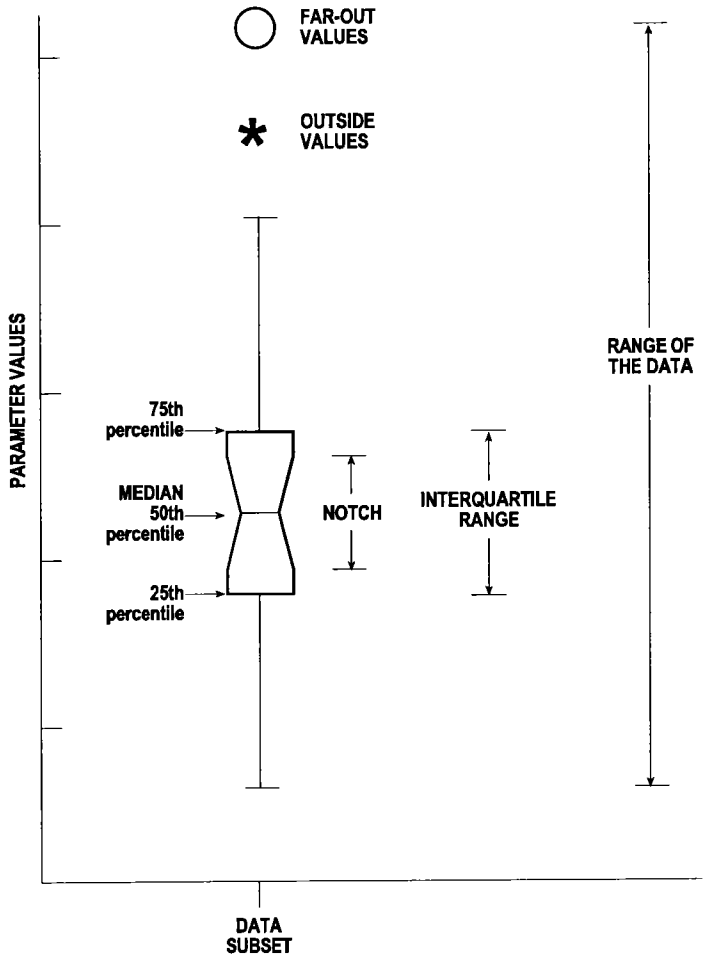
Analyte	Concentration One	Q	Concentration Two	Q	Mean Concentration	Relative Percent Difference
Sample 23-2-T						
Aluminum	11000.0	D	11500.0	D	11250.0	-4.4
Arsenic	12.2	D	10.8	D	11.5	12.2
Barium	78.7	D	75.1	D	76.9	4.7
Beryllium	0.43	U	0.43	U	0.43	0.0
Cadmium	0.28	U	0.29	U	0.28	-3.5
Calcium	23500.0	D	56900.0	D	40200.0	-83.1
Chromium	14.0	D	14.5	D	14.3	-3.5
Cobalt	22.3	D	21.6	D	21.9	3.2
Copper	19.3	D	18.2	D	18.8	5.9
Iron	26800.0	D	24700.0	D	25750.0	8.2
Lead	17.4	D	16.5	D	16.9	5.3
Magnesium	2160.0	D	5170.0	D	3665.0	-82.1
Manganese	541.0	D	550.0	D	545.5	-1.6
Mercury	0.035	U	0.050	U	0.043	-35.3
Nickel	15.1	D	15.9	D	15.5	-5.2
Potassium	957.0	D	1060.0	D	1008.5	-10.2
Selenium	0.28	U	0.29	U	0.28	-3.5
Silver	0.49	U	0.55	U	0.52	-11.5
Sodium	31.0	U	36.8	U	33.9	-16.8
Thallium	0.28	U	0.29	U	0.28	-3.5
Vanadium	20.8	D	19.6	D	20.2	5.9
Zinc	44.0	D	48.7	D	46.4	-10.1
Sample HCS-BR2						
Aluminum	7270.0	D	3320.0	D	5295.0	74.6
Antimony	17.5	D	ND		17.5	0.0
Arsenic	6.5	D	6.1	D	6.3	6.3
Barium	138.0	D	45.2	D	91.6	101.3
Beryllium	0.32	U	0.97	D	0.65	-100.8
Cadmium	0.36	U	0.28	U	0.32	23.3
Calcium	32300.0	D	1040.0	D	16670.0	187.5
Chromium	11.7	D	7.6	D	9.6	42.5
Cobalt	4.6	U	28.6	D	16.6	-145.1
Copper	20.1	D	15.1	D	17.6	28.4
Cyanide	0.65	U	0.60	U	0.63	8.0
Iron	18900.0	D	21500.0	D	20200.0	-12.9
Lead	41.6	D	16.9	D	29.2	84.4
Magnesium	4760.0	D	209.5	U	2484.8	183.1
Manganese	586.0	D	628.0	D	607.0	-6.9
Mercury	0.15	D	0.19	D	0.17	-23.5
Nickel	16.3	D	38.9	D	27.6	-81.9
Potassium	1490.0	D	185.0	U	837.5	155.8
Selenium	0.48	U	0.87	D	0.67	-57.8
Silver	0.60	U	1.20	D	0.90	-66.7
Sodium	39.2	U	79.0	U	59.1	-67.5
Thallium	0.48	U	0.38	U	0.43	22.0
Vanadium	25.5	D	12.9	D	19.2	65.6
Zinc	75.1	D	138.0	D	106.5	-59.0

Notes
Q = Data-validation qualifier
D - Detected at the indicated concentration
U = Not detected above the indicated concentration
ND = Data not available
All units are milligrams per kilogram

Table A-2
Duplicate Relative Percent Differences
ABL Soil-Background Evaluation for Inorganics

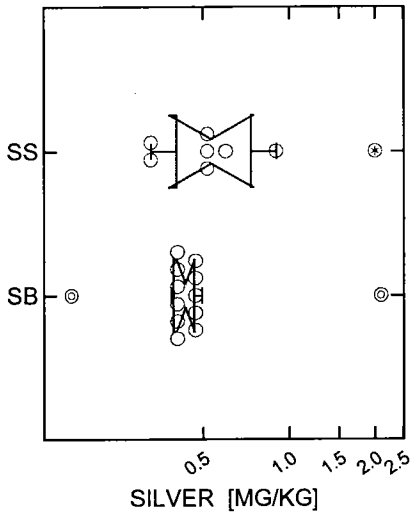
Analyte	Number of Values	Relative Percent Difference		
		Minimum	Maximum	Mean
Aluminum	2	-4	75	35
Antimony	1	0	0	0
Arsenic	2	6	12	9
Barium	2	5	101	53
Beryllium	2	-101	0	-50
Cadmium	2	-4	23	10
Calcium	2	-83	188	52
Chromium	2	-4	43	20
Cobalt	2	-145	3	-71
Copper	2	6	28	17
Cyanide	1	8	8	8
Iron	2	-13	8	-2
Lead	2	5	84	45
Magnesium	2	-82	183	51
Manganese	2	-2	7	3
Mercury	2	-35	-24	-30
Nickel	2	-82	-5	-43
Potassium	2	-10	156	73
Selenium	2	-58	-4	-31
Silver	2	-66	-12	-39
Sodium	2	-67	-17	-42
Thallium	2	-4	22	9
Vanadium	2	6	66	36
Zinc	2	-59	-10	-35

Appendix B
Boxplots and Mann-Whitney Evaluation

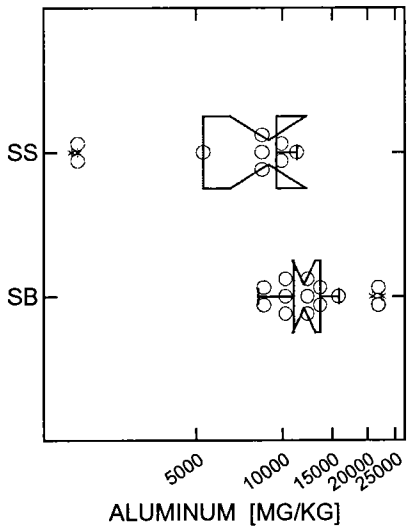


Components. A **BOX PLOT** identifies the **MEDIAN**, (50th percentile), the lower and upper quartiles **(25th and 75th PERCENTILES)**, and the **RANGE** (extreme spread of the data). The edges of the box demarcate the 25th and 75th percentiles, and so represent the middle 50 percent **(INTERQUARTILE RANGE)** of the parameter values for the data subset. The line inside the box is the **MEDIAN**. The lines, or whiskers, extend outward from the box through the range of data, excluding outliers. Two outliers are defined, based on their distance from the nearest edge of the box, relative to the range of the box. **OUTSIDE VALUES** lie 1.5 to 3 interquartile ranges away from the nearest box edge, and **FAR-OUT VALUES** lie three or more interquartile ranges away form the nearest box edge. The **NOTCH** represents the approximate 95 percent confidence interval around the median.

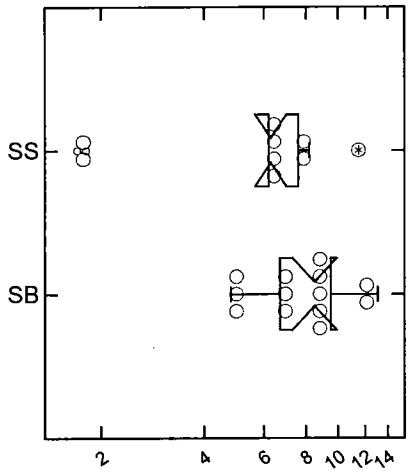
Interpretation. If notches from different subsets of data overlap completely, one can conclude with 95% confidence that the groups have been sampled from a common population. If notches do not overlap at all, one can conclude (with 95% confidence) that the groups represent different populations. Cases of partial overlap require explicit tests (e.g., t-Test, ANOVA, Mann-Whitney, or Kruskal-Wallis) to specify significance of differences among groups.



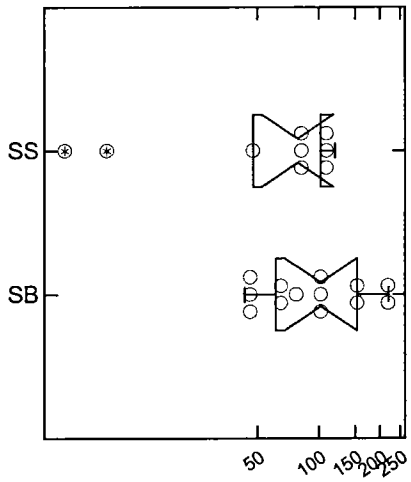
SILVER [MG/KG]



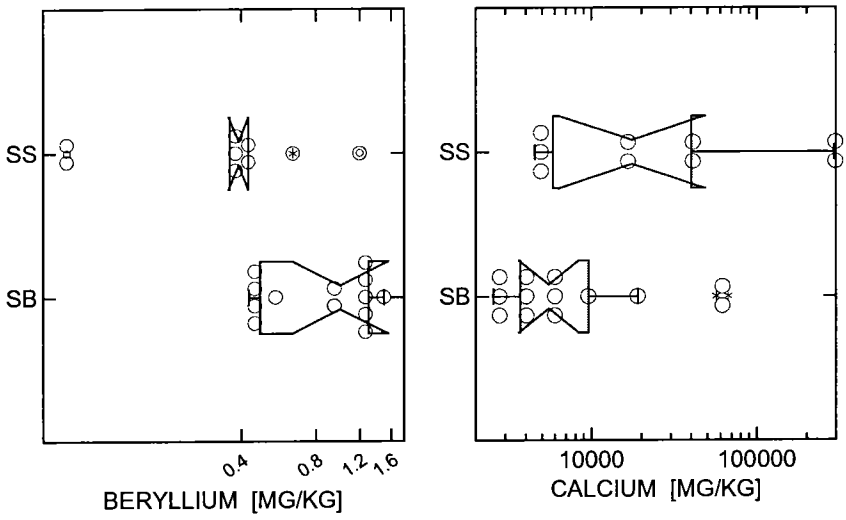
ALUMINUM [MG/KG]

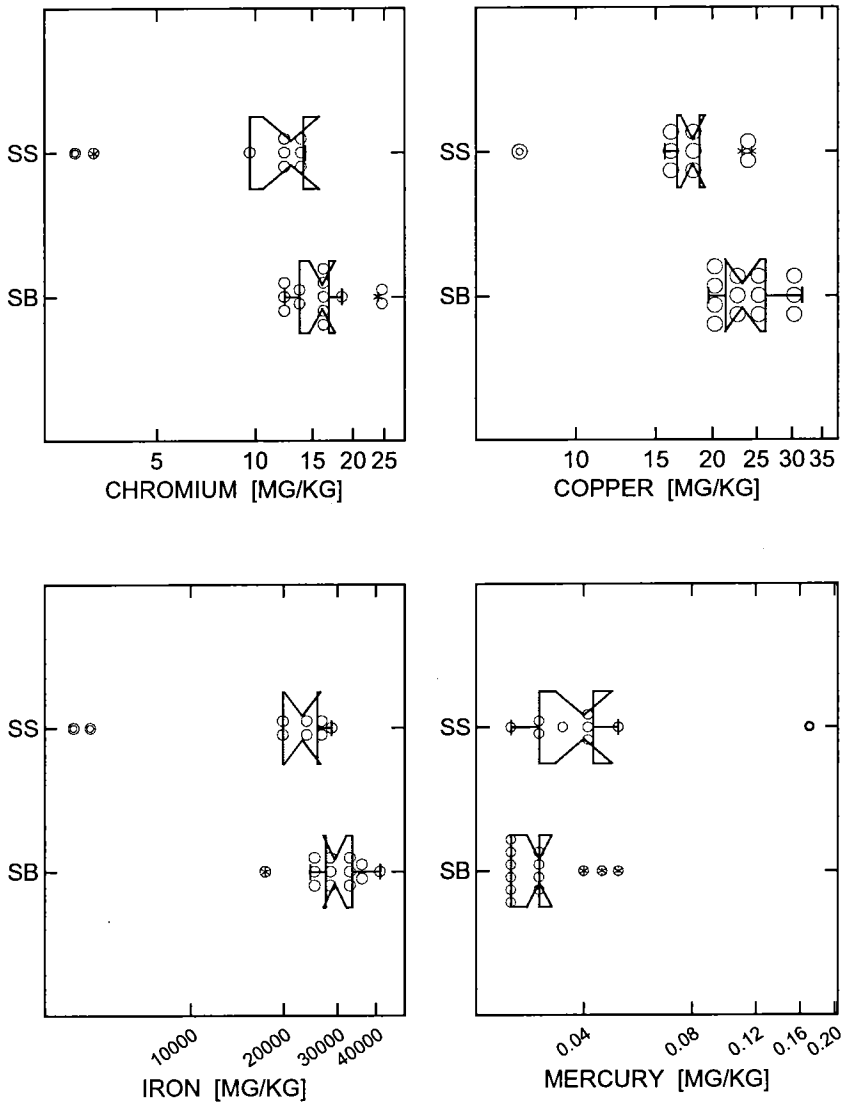


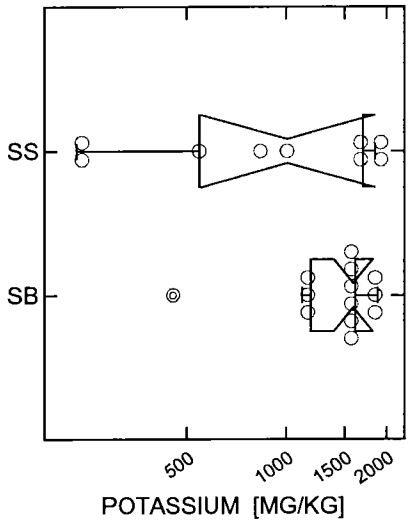
ARSENIC [MG/KG]



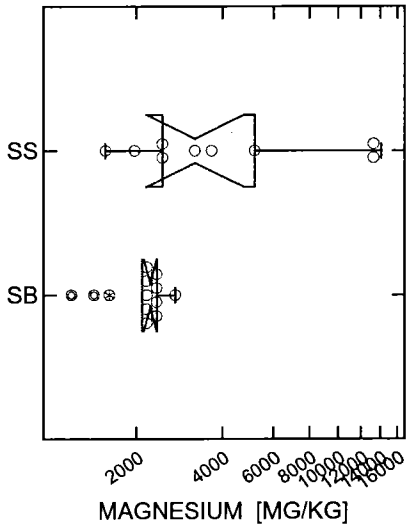
BARIUM [MG/KG]


SS
SB
0.4
0.8
1.2
1.6
BERYLLIUM [MG/KG]
SS
SB
10000
100000
CALCIUM [MG/KG]
SS
SB
0.5
1.0
1.5
2.0
2.5
CADMIUM [MG/KG]
SS
SB
5
10
15
20
25
COBALT [MG/KG]

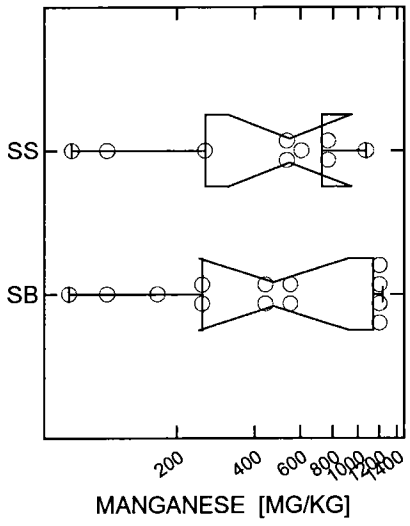

SS
SB
5
10
15
20
25
CHROMIUM [MG/KG]
SS
SB
10
15
20
25
30
35
COPPER [MG/KG]
SS
SB
10000
20000
30000
40000
IRON [MG/KG]
SS
SB
0.04
0.08
0.12
0.16
0.20
MERCURY [MG/KG]



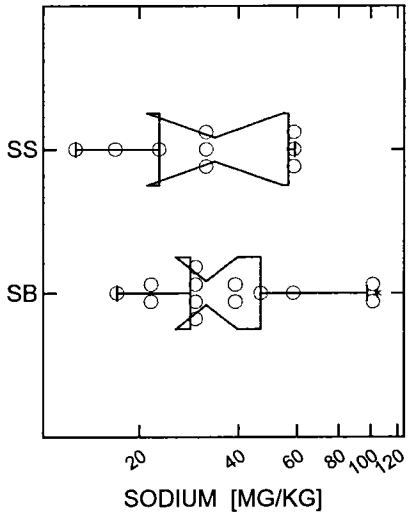
POTASSIUM [MG/KG]



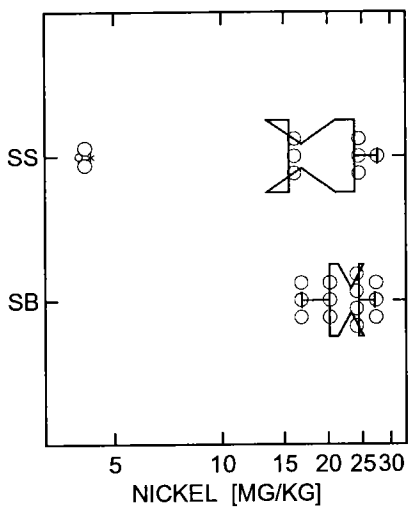
MAGNESIUM [MG/KG]

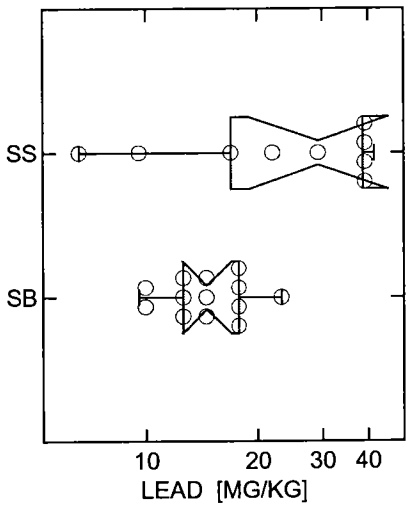


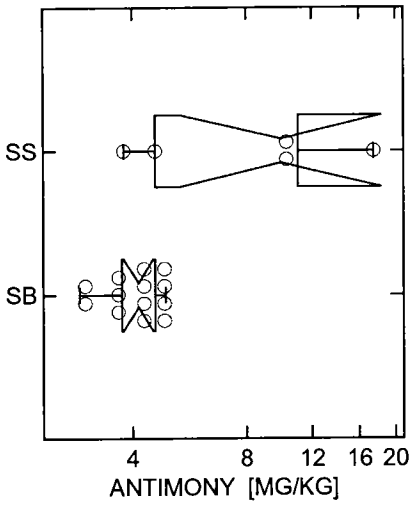
MANGANESE [MG/KG]

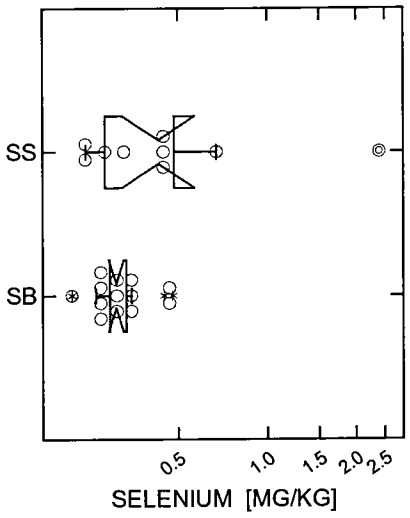


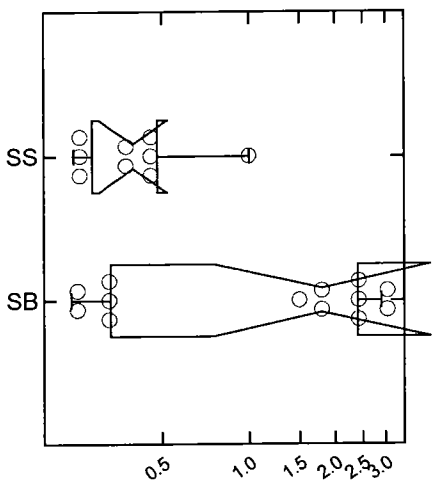
SODIUM [MG/KG]


SS
SB
5
10
15
20
25
30
NICKEL [MG/KG]

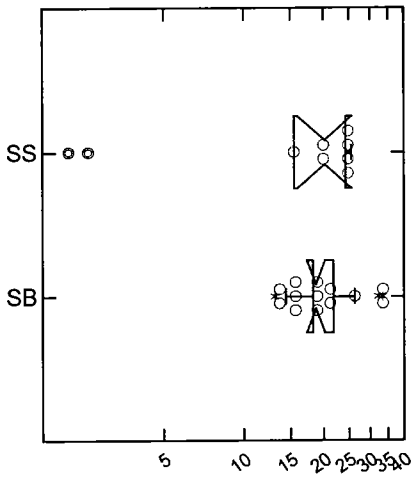

SS
SB
10
20
30
40
LEAD [MG/KG]


SS
SB
4
8
12
16
20
ANTIMONY [MG/KG]

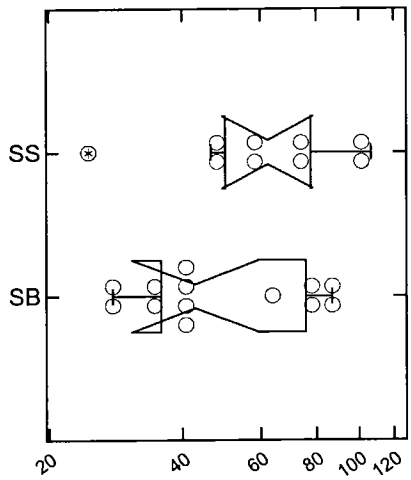

SS
SB
0.5
1.0
1.5
2.0
2.5
SELENIUM [MG/KG]



THALLIUM [MG/KG]



VANADIUM [MG/KG]



ZINC [MG/KG]

Table B-1
Mann-Whitney Evaluation Comparing Surface and Subsurface Results
ABL Soil-Background Evaluation for Inorganics

Analyte	MW	Inequality
Aluminum	0.002	SS < SB
Antimony	0.04	SS > SB
Arsenic	0.12	
Barium	0.29	
Beryllium	0.002	SS < SB
Cadmium	0.50	
Calcium	0.07	
Chromium	0.01	SS < SB
Cobalt	0.27	
Copper	0.002	SS < SB
Iron	0.004	SS < SB
Lead	0.07	
Mercury	0.06	
Magnesium	0.02	SS > SB
Manganese	0.95	
Potassium	0.39	
Nickel	0.26	
Selenium	0.26	
Silver	0.12	
Sodium	0.71	
Thallium	0.10	
Vanadium	0.95	
Zinc	0.22	

Note:

MW = Probabilities of the Mann-Whitney test statistic which are less than or equal to 0.05 are considered "significant", which means that surface and subsurface samples have not been collected from a common population

SS = Surface soil

SB = Subsurface soil

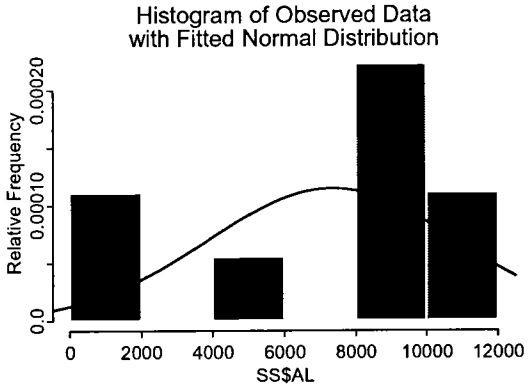
"<" = Results for surface soil statistically are less than those for subsurface soil

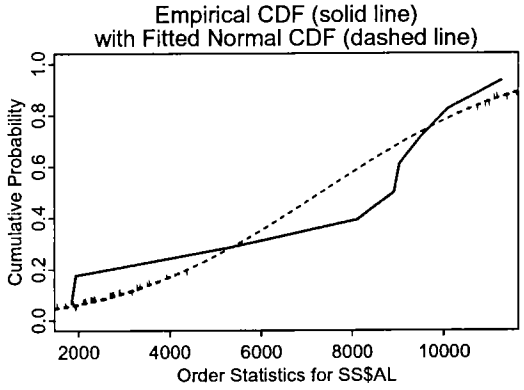
">" = Results for surface soil statistically are greater than those for subsurface soil

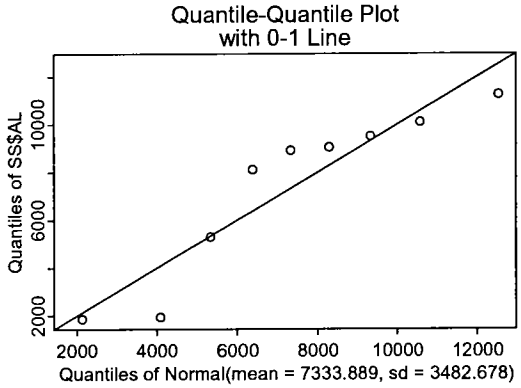
Appendix C
Goodness-of-Fit Testing Results

Surface Soil

Results of Shapiro-Wilk GOF Test for SS$AL



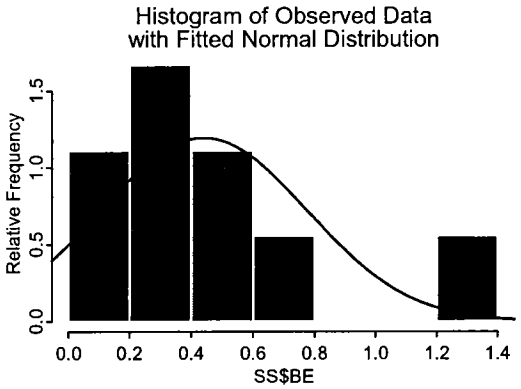


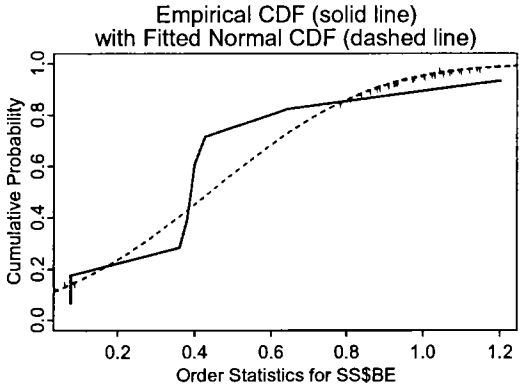


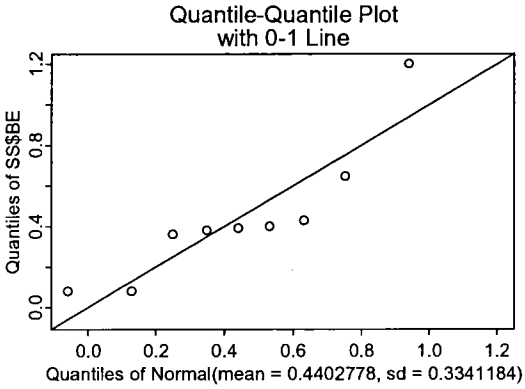
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 7333.889 sd = 3482.678
Data:	SS$AL
Sample Size:	9
Test Statistic:	W = 0.8535306
Test Statistic Parmeter:	n = 9
P-value:	0.08148537

Results of Shapiro-Wilk GOF Test for SS$BE



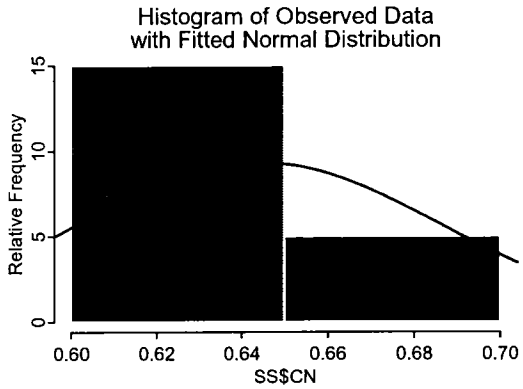


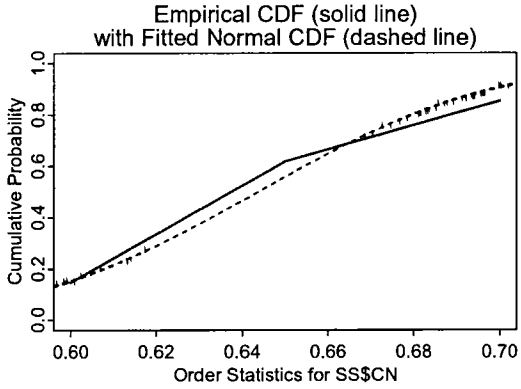


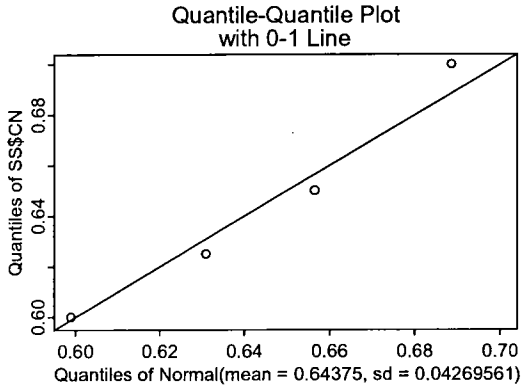
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.4402778 sd = 0.3341184
Data:	SS$BE
Sample Size:	9
Test Statistic:	W = 0.8235766
Test Statistic Parmeter:	n = 9
P-value:	0.03781337

Results of Shapiro-Wilk GOF Test for SS$CN



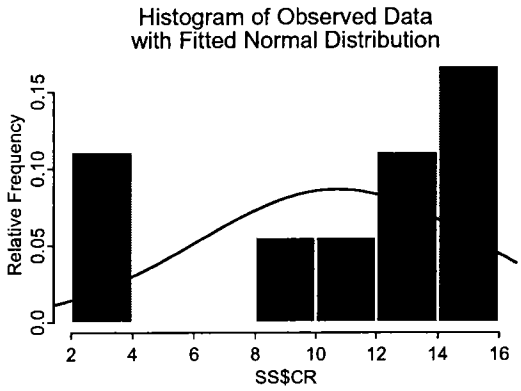


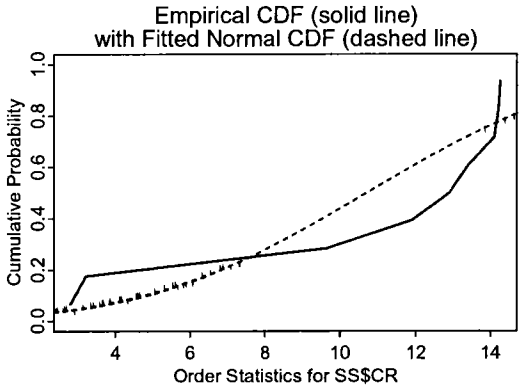


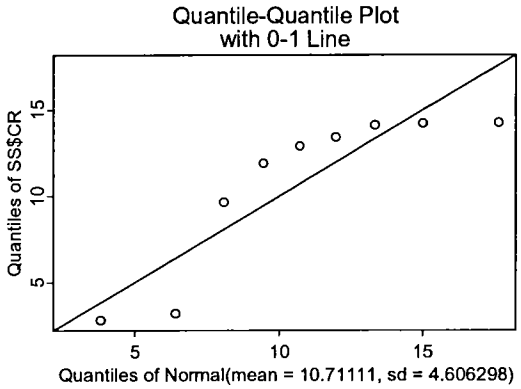
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.64375 sd = 0.04269561
Data:	SS$CN
Sample Size:	4
Test Statistic:	W = 0.9713736
Test Statistic Parmeter:	n = 4
P-value:	0.8499702

Results of Shapiro-Wilk GOF Test for SS$CR



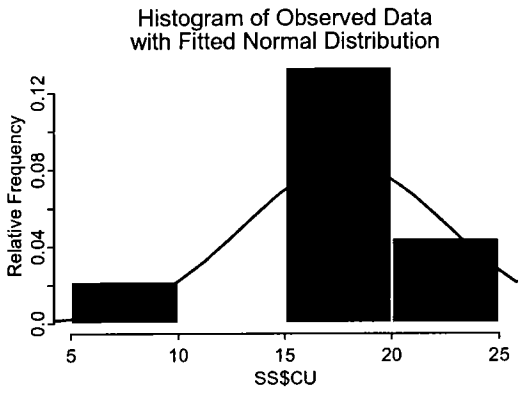


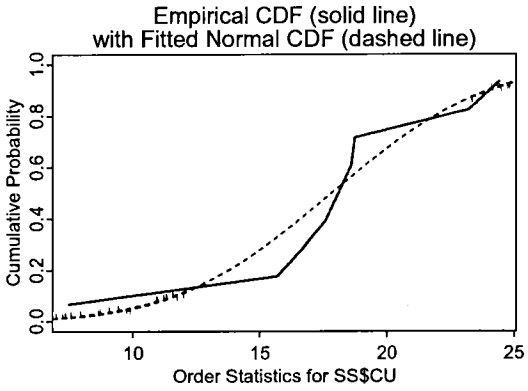


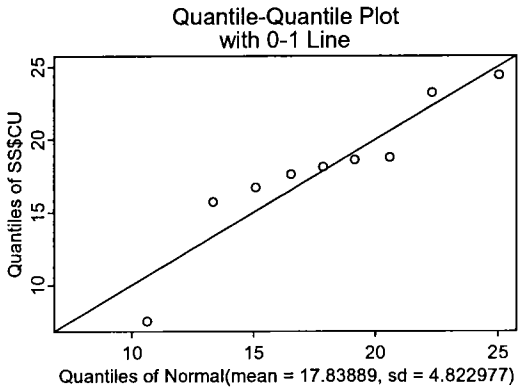
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 10.71111 sd = 4.606298
Data:	SS$CR
Sample Size:	9
Test Statistic:	W = 0.7562804
Test Statistic Parmeter:	n = 9
P-value:	0.006410798

Results of Shapiro-Wilk GOF Test for SS$CU



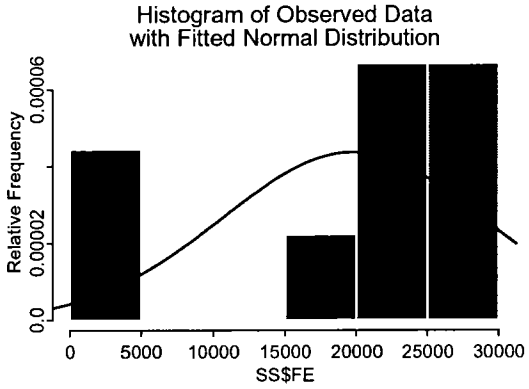


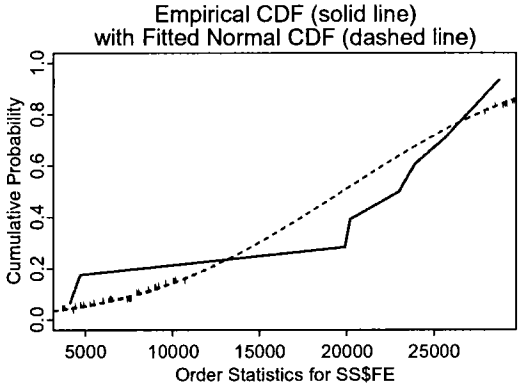


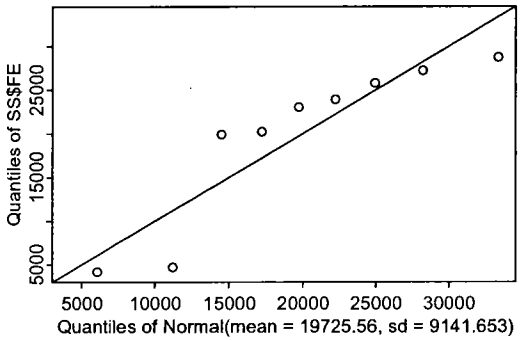
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 17.83889 sd = 4.822977
Data:	SS$CU
Sample Size:	9
Test Statistic:	W = 0.891522
Test Statistic Parmeter:	n = 9
P-value:	0.2068332

Results of Shapiro-Wilk GOF Test for SS$FE



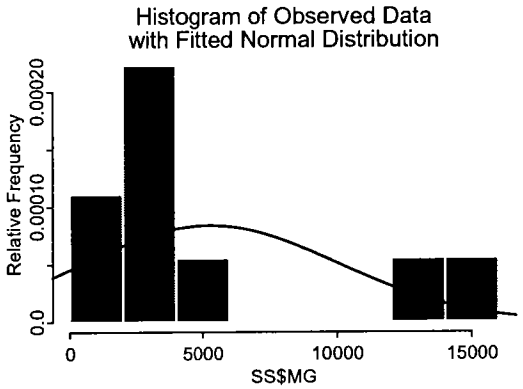


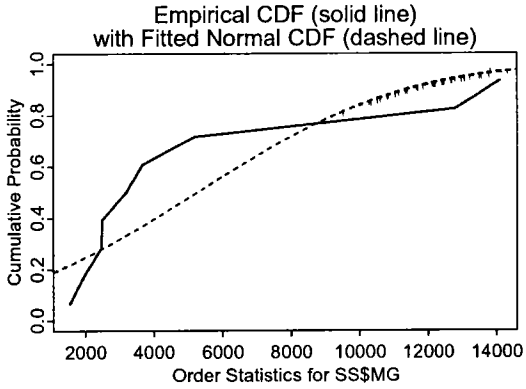


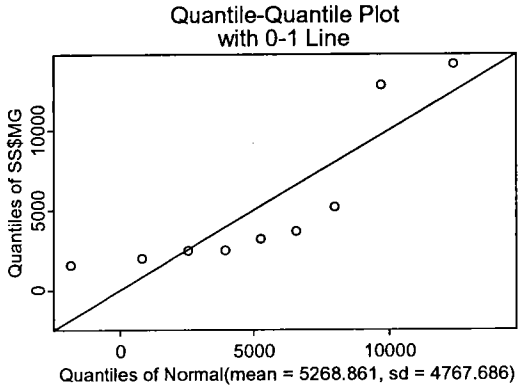
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 1.972556e4 sd = 9141.653
Data:	SS$FE
Sample Size:	9
Test Statistic:	W = 0.8080028
Test Statistic Parmeter:	n = 9
P-value:	0.02519334

Results of Shapiro-Wilk GOF Test for SS$MG



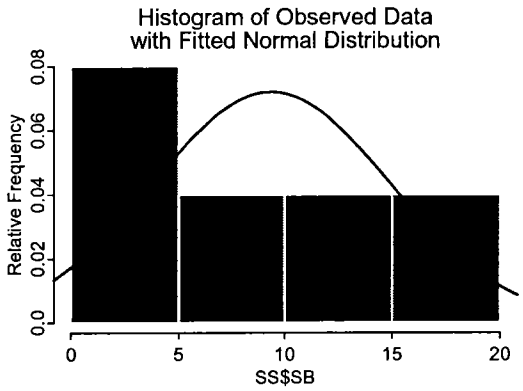


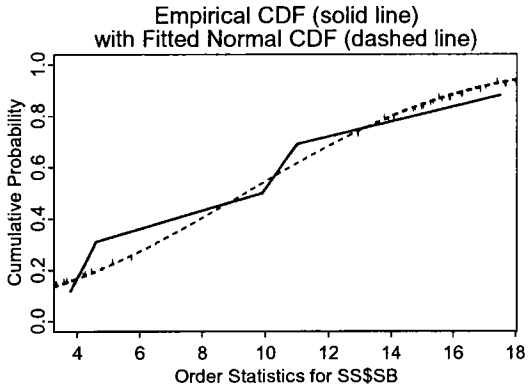


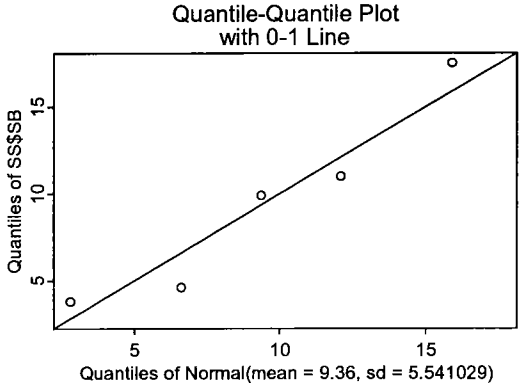
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 5268.861 sd = 4767.686
Data:	SS$MG
Sample Size:	9
Test Statistic:	W = 0.7326613
Test Statistic Parmeter:	n = 9
P-value:	0.003410012

Results of Shapiro-Wilk GOF Test for SS$SB





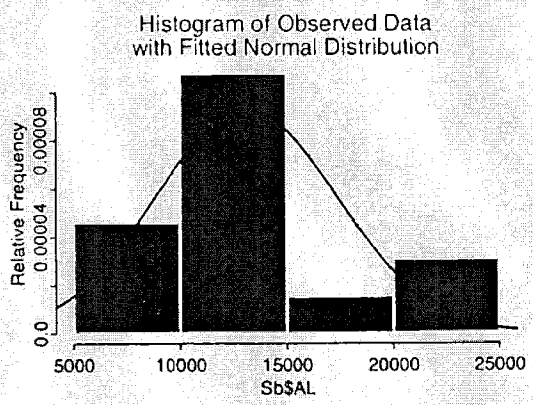


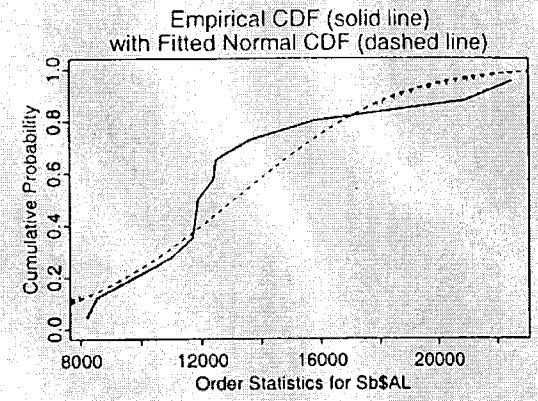
Results of Shapiro-Wilk GOF

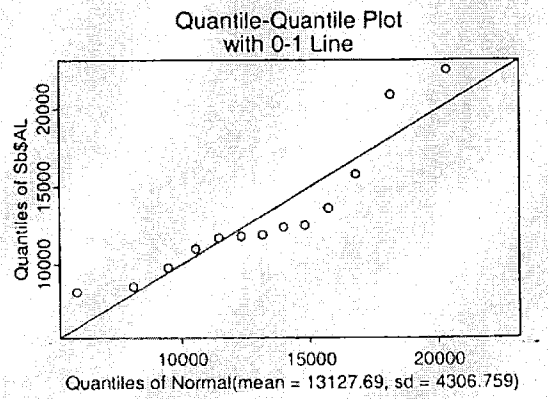
Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 9.36 sd = 5.541029
Data:	SS$SB
Sample Size:	5
Test Statistic:	W = 0.9235912
Test Statistic Parmeter:	n = 5
P-value:	0.5533664

Subsurface Soil

Results of Shapiro-Wilk GOF Test for Sb$AL



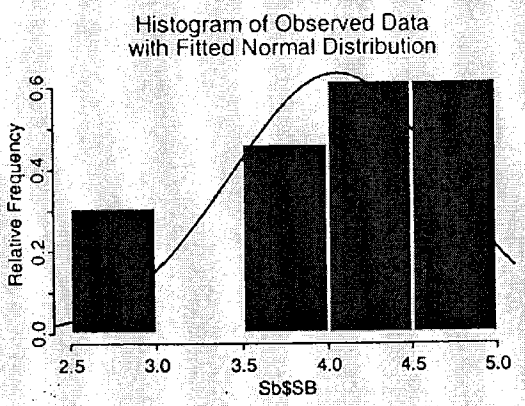


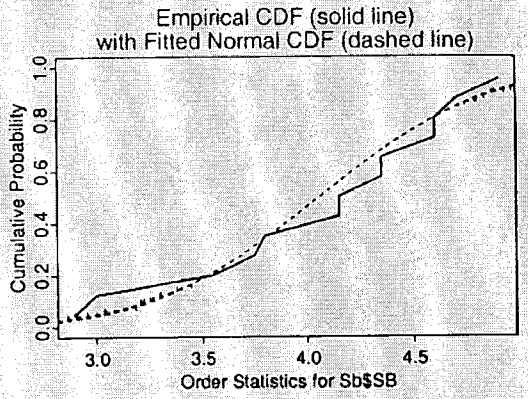


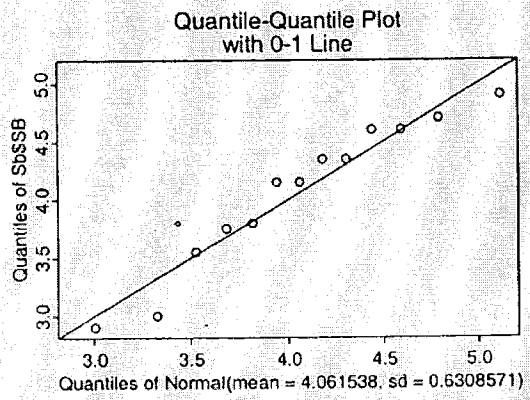
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 1.31276 9e4 sd = 4306.759
Data:	Sb$AL
Sample Size:	13
Test Statistic:	W = 0.8512549
Test Statistic Parmeter:	n = 13
P-value:	0.02959502

Results of Shapiro-Wilk GOF Test for Sb$SB



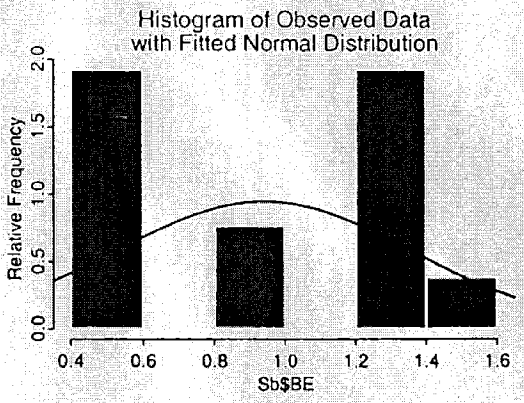


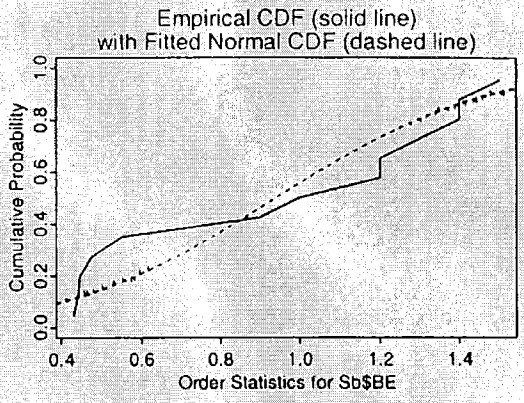


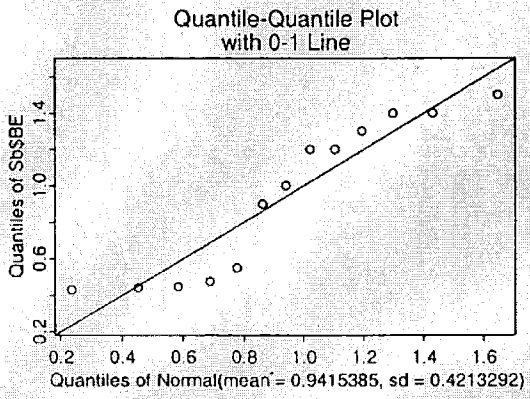
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 4.061538 sd = 0.6308571
Data:	Sb$SB
Sample Size:	13
Test Statistic:	W = 0.9290432
Test Statistic Parmeter:	n = 13
P-value:	0.331123

Results of Shapiro-Wilk GOF Test for Sb$BE



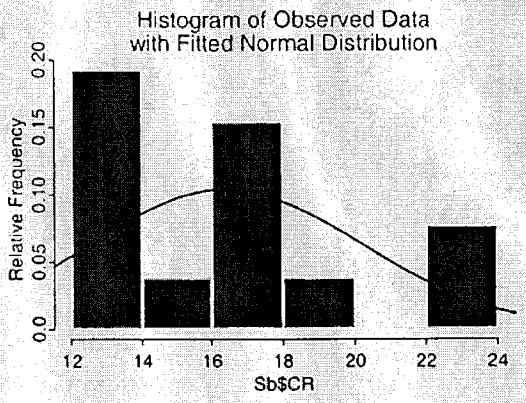


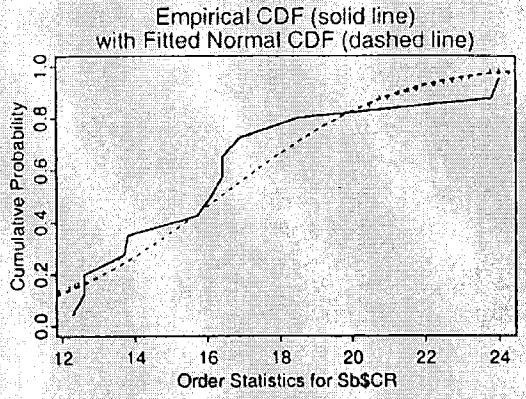


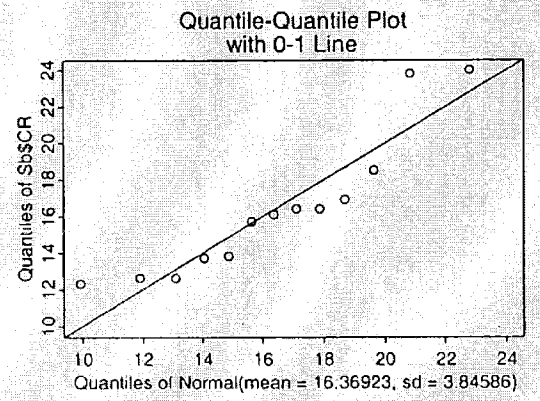
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.9415385 sd = 0.4213292
Data:	Sb$BE
Sample Size:	13
Test Statistic:	W = 0.8582775
Test Statistic Parmeter:	n = 13
P-value:	0.03656361

Results of Shapiro-Wilk GOF Test for Sb$CR



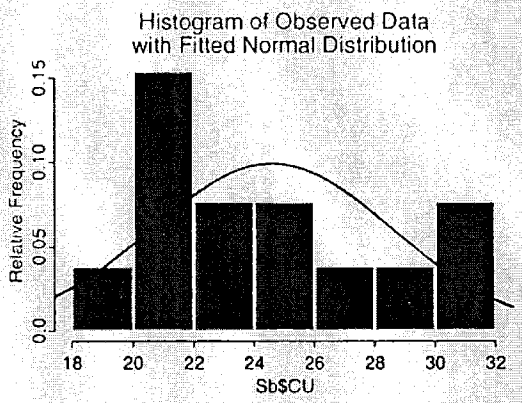


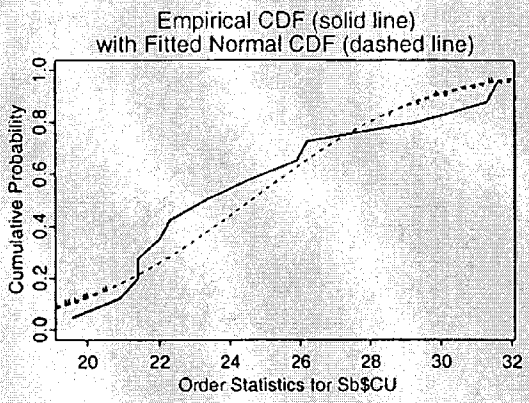


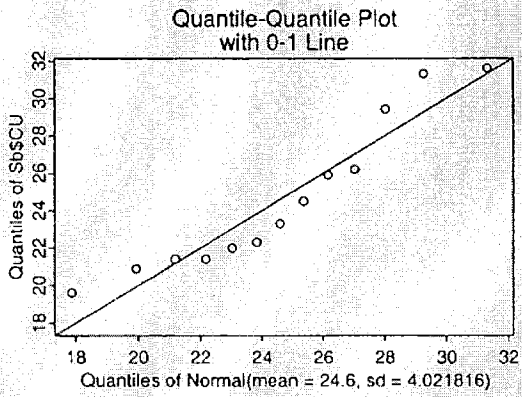
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 16.36923 sd = 3.84586
Data:	Sb$CR
Sample Size:	13
Test Statistic:	W = 0.8498299
Test Statistic Parmeter:	n = 13
P-value:	0.02836034

Results of Shapiro-Wilk GOF Test for Sb$CU



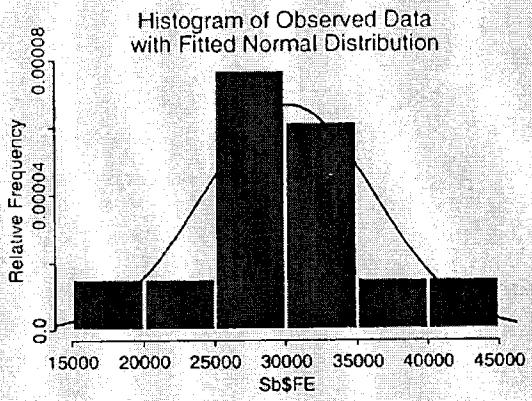


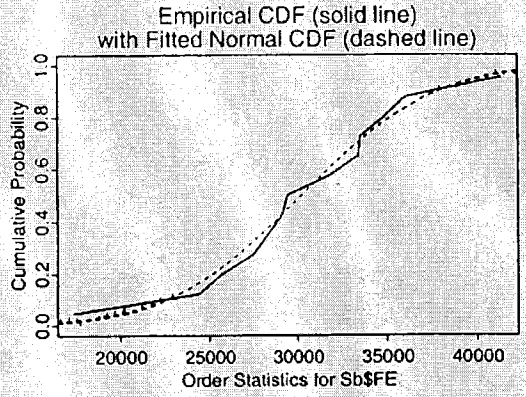


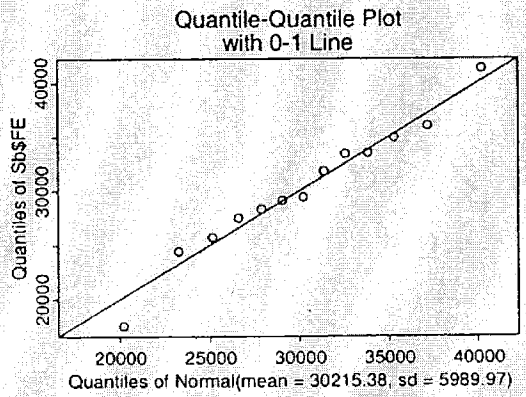
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 24.6 sd = 4.021816
Data:	Sb$CU
Sample Size:	13
Test Statistic:	W = 0.8956413
Test Statistic Parmeter:	n = 13
P-value:	0.1165296

Results of Shapiro-Wilk GOF Test for Sb$FE



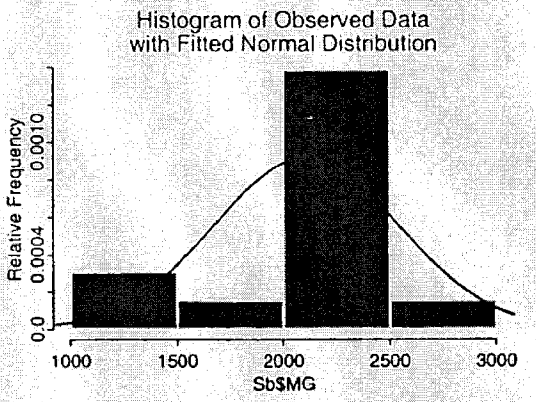


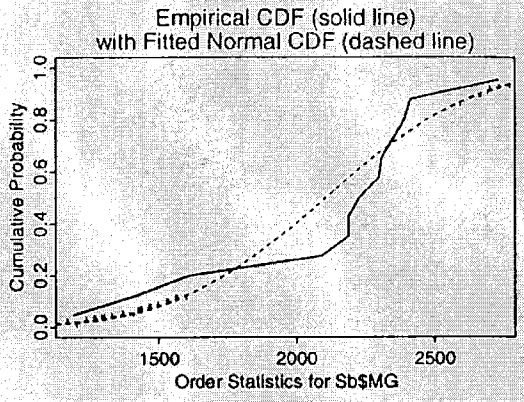


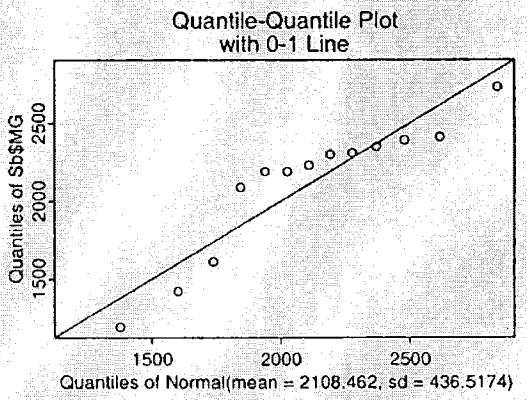
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 3.021538e4 sd = 5989.97
Data:	Sb$FE
Sample Size:	13
Test Statistic:	W = 0.9818906
Test Statistic Parmeter:	n = 13
P-value:	0.9874041

Results of Shapiro-Wilk GOF Test for Sb$MG







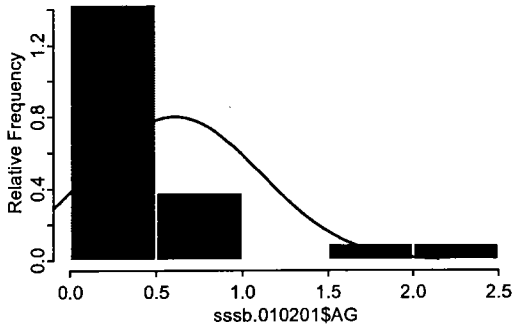
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 2108.462 sd = 436.5174
Data:	Sb$MG
Sample Size:	13
Test Statistic:	W = 0.8641419
Test Statistic Parmeter:	n = 13
P-value:	0.04370235

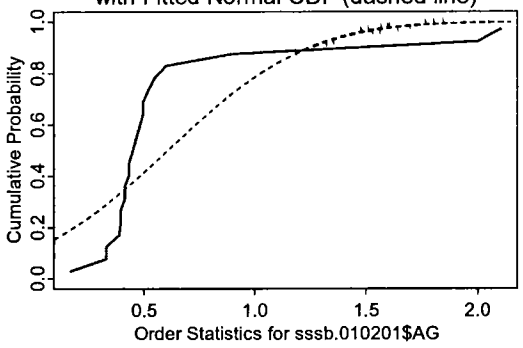
Pooled Surface Soil and Subsurface Soil

Results of Shapiro-Wilk GOF Test for sssb.010201$AG

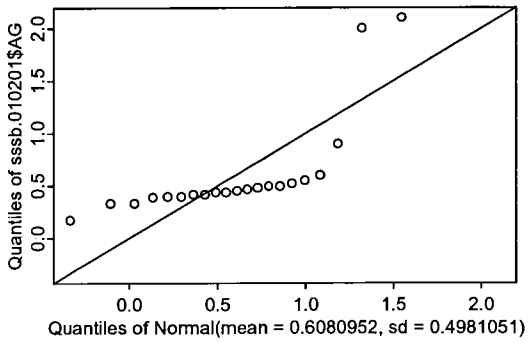
Histogram of Observed Data
with Fitted Normal Distribution



Empirical CDF (solid line)
with Fitted Normal CDF (dashed line)



Quantile-Quantile Plot
with 0-1 Line

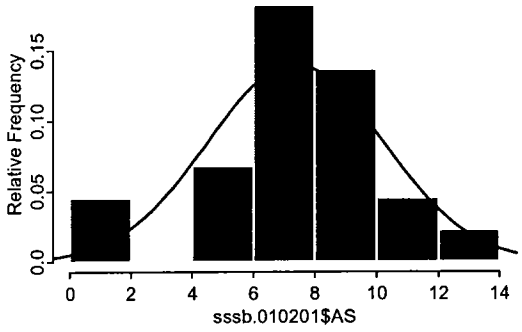


Results of Shapiro-Wilk GOF

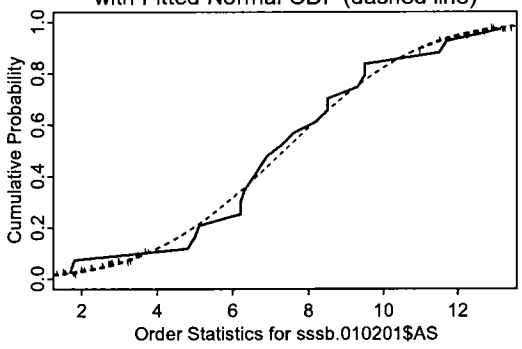
Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.6080952 sd = 0.4981051
Data:	sssb.010201$AG
Sample Size:	21
Test Statistic:	W = 0.5693895
Test Statistic Parmeter:	n = 21
P-value:	9.503544e-7

Results of Shapiro-Wilk GOF Test for sssb.010201$AS

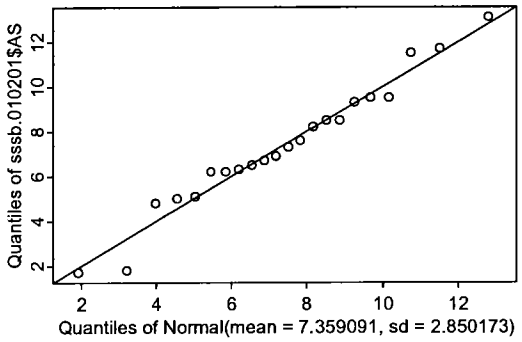
Histogram of Observed Data
with Fitted Normal Distribution



Empirical CDF (solid line)
with Fitted Normal CDF (dashed line)



Quantile-Quantile Plot
with 0-1 Line

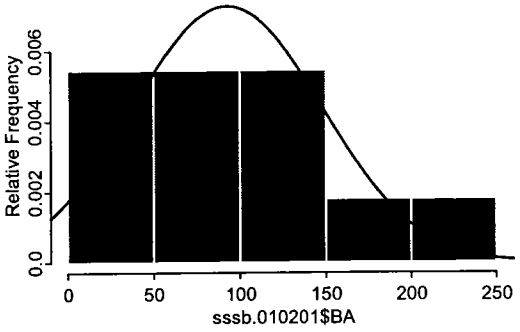


Results of Shapiro-Wilk GOF

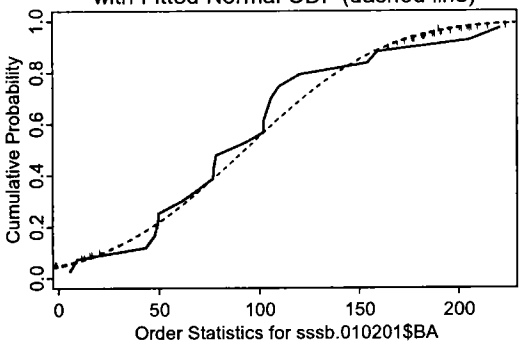
Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 7.359091 sd = 2.850173
Data:	sssb.010201$AS
Sample Size:	22
Test Statistic:	W = 0.9696782
Test Statistic Parmeter:	n = 22
P-value:	0.7036144

Results of Shapiro-Wilk GOF Test for sssb.010201$BA

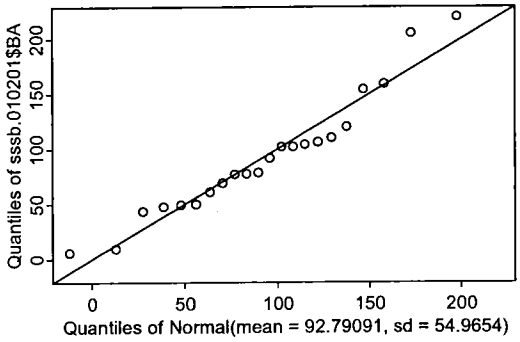
Histogram of Observed Data
with Fitted Normal Distribution



Empirical CDF (solid line)
with Fitted Normal CDF (dashed line)



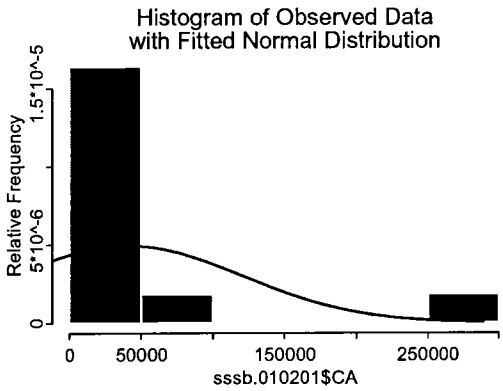
Quantile-Quantile Plot
with 0-1 Line

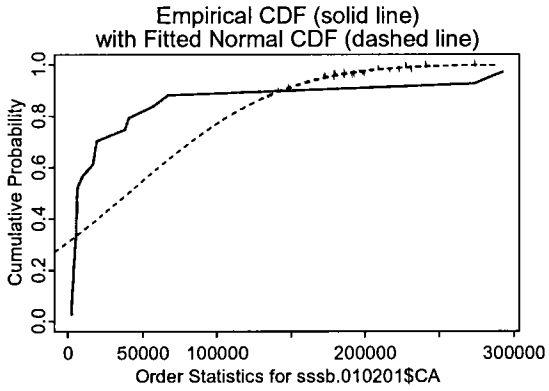


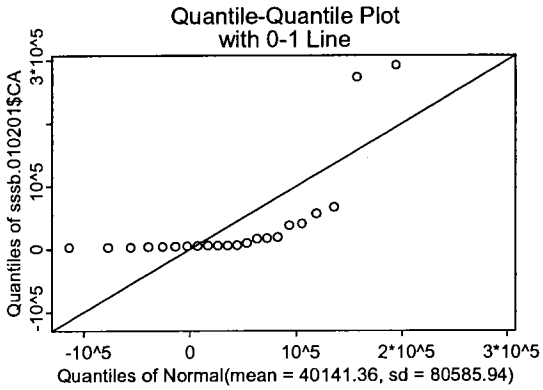
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 92.79091 sd = 54.9654
Data:	sssb.010201$BA
Sample Size:	22
Test Statistic:	W = 0.9420357
Test Statistic Parmeter:	n = 22
P-value:	0.2179757

Results of Shapiro-Wilk GOF Test for sssb.010201$CA



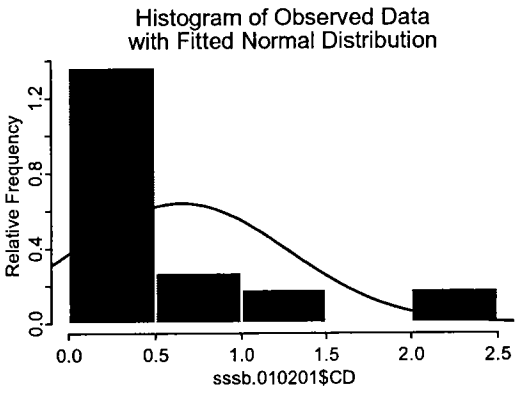


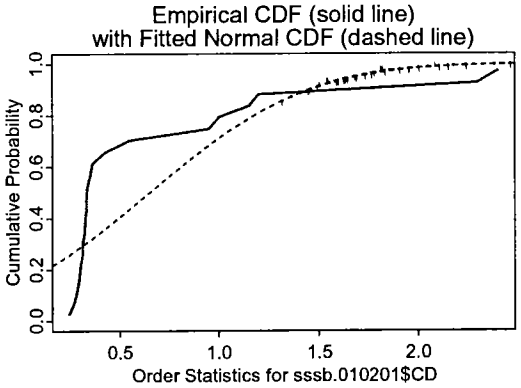


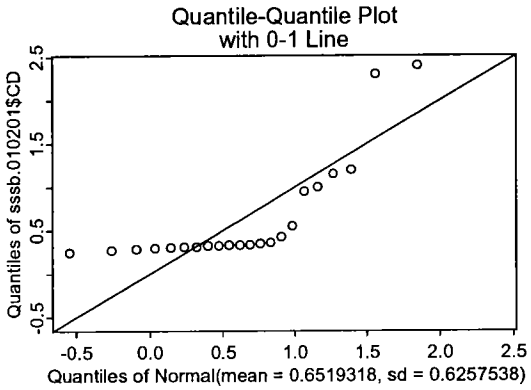
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 4.014136e4 sd = 8.058594e4
Data:	sssb.010201$CA
Sample Size:	22
Test Statistic:	W = 0.4983266
Test Statistic Parmeter:	n = 22
P-value:	1.267644e-7

Results of Shapiro-Wilk GOF Test for sssb.010201$CD



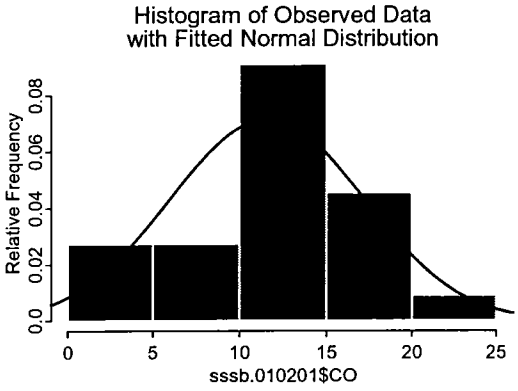


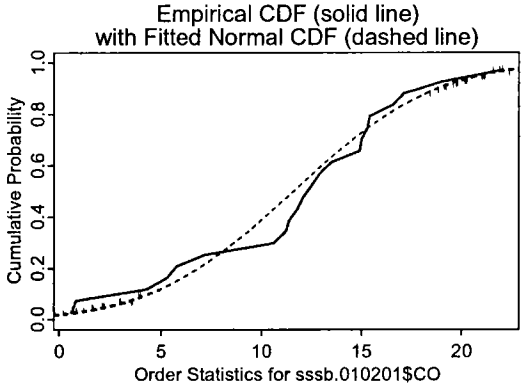


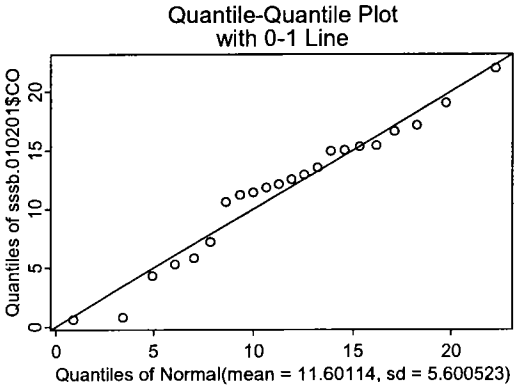
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.6519318 sd = 0.6257538
Data:	sssb.010201$CD
Sample Size:	22
Test Statistic:	W = 0.6446831
Test Statistic Parmeter:	n = 22
P-value:	4.182132e-6

Results of Shapiro-Wilk GOF Test for sssb.010201$CO



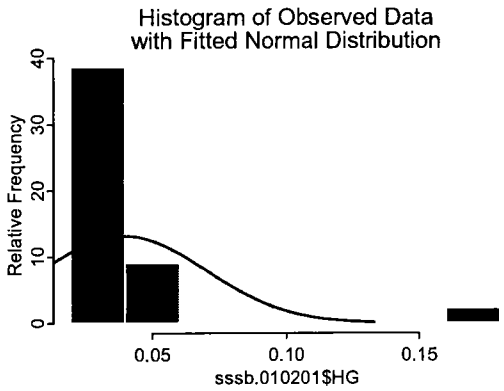


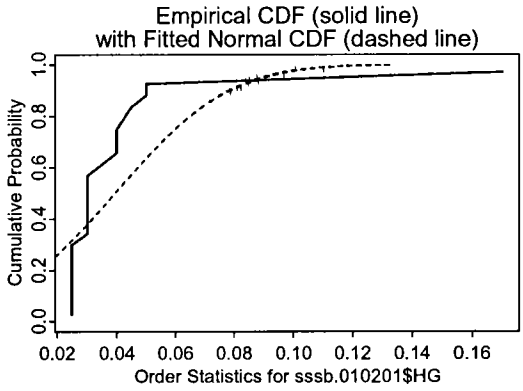


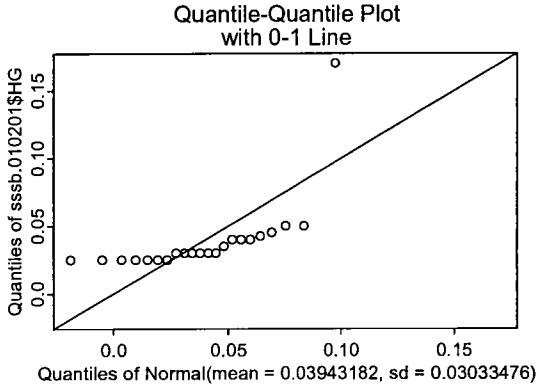
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 11.60114 sd = 5.600523
Data:	sssb.010201$CO
Sample Size:	22
Test Statistic:	W = 0.956654
Test Statistic Parmeter:	n = 22
P-value:	0.424743

Results of Shapiro-Wilk GOF Test for sssb.010201$HG



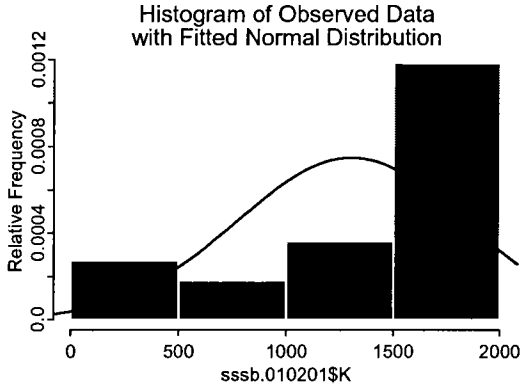


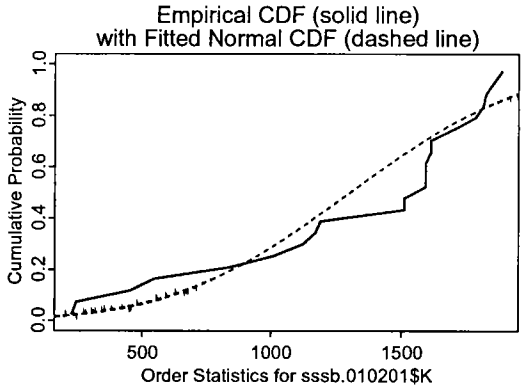


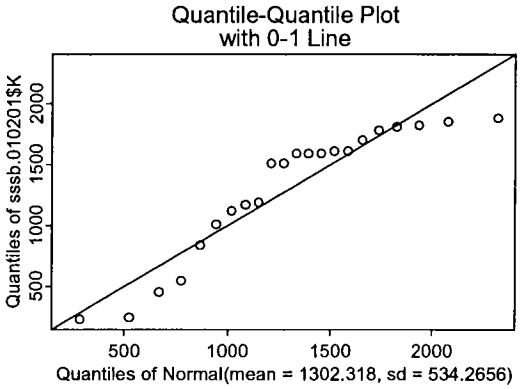
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.03943182 sd = 0.03033476
Data:	sssb.010201$HG
Sample Size:	22
Test Statistic:	W = 0.4512531
Test Statistic Parmeter:	n = 22
P-value:	4.726521e-8

Results of Shapiro-Wilk GOF Test for sssb.010201$K



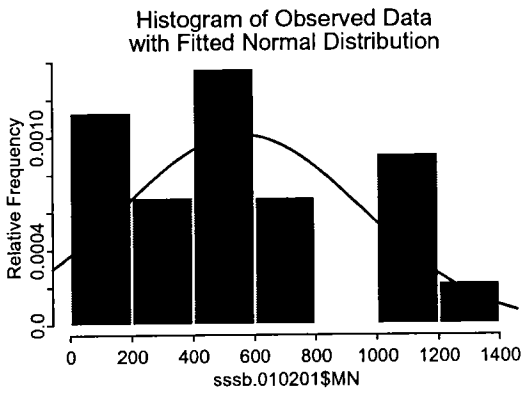


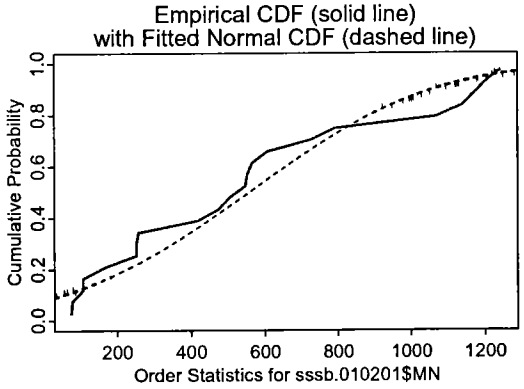


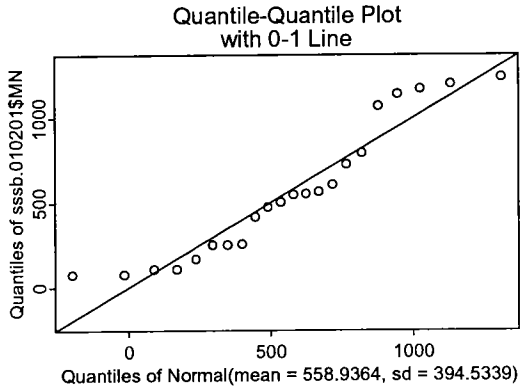
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 1302.318 sd = 534.2656
Data:	sssb.010201$K
Sample Size:	22
Test Statistic:	W = 0.8622959
Test Statistic Parmeter:	n = 22
P-value:	0.005645245

Results of Shapiro-Wilk GOF Test for sssb.010201$MN



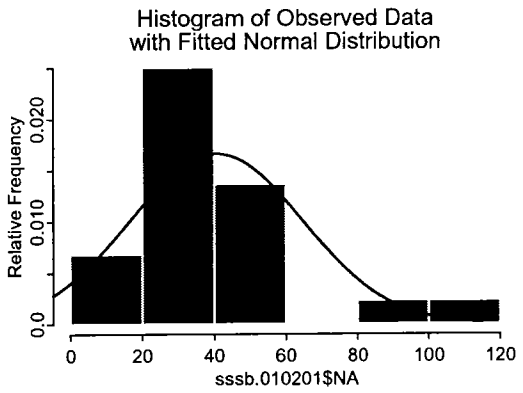


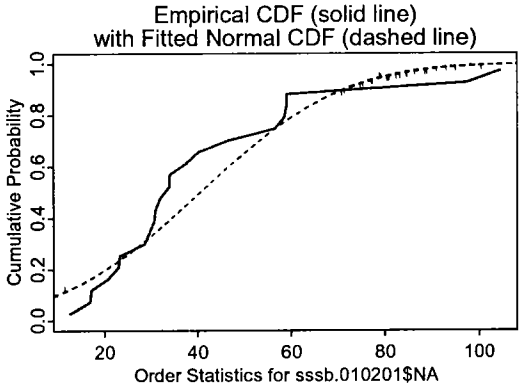


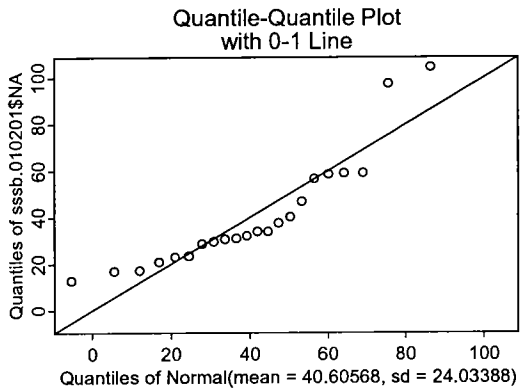
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 558.9364 sd = 394.5339
Data:	sssb.010201$MN
Sample Size:	22
Test Statistic:	W = 0.9011311
Test Statistic Parmeter:	n = 22
P-value:	0.03131745

Results of Shapiro-Wilk GOF Test for sssb.010201$NA



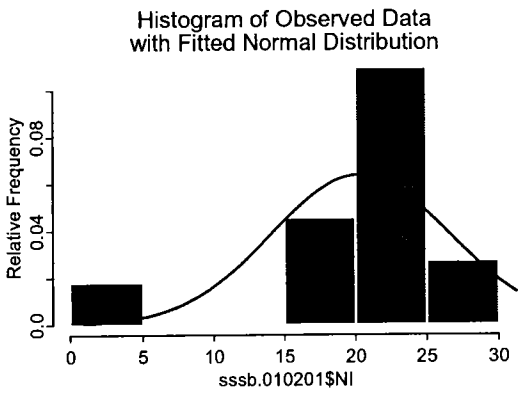


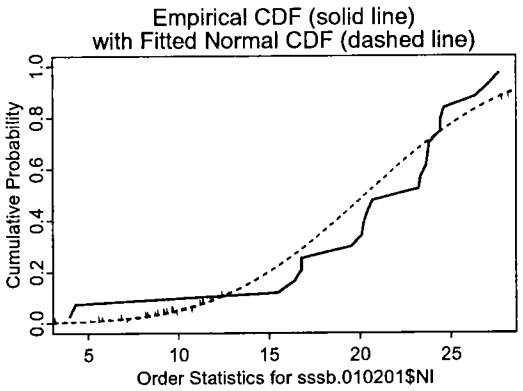


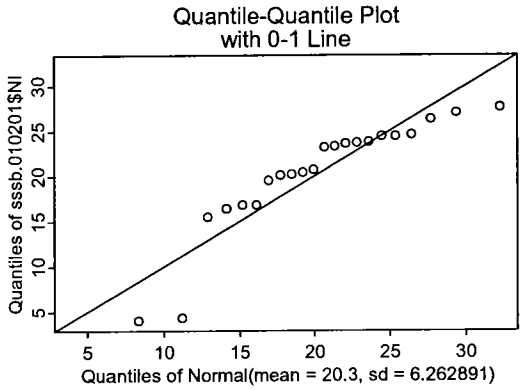
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 40.60568 sd = 24.03388
Data:	sssb.010201$NA
Sample Size:	22
Test Statistic:	W = 0.8426775
Test Statistic Parmeter:	n = 22
P-value:	0.0025264

Results of Shapiro-Wilk GOF Test for sssb.010201$NI



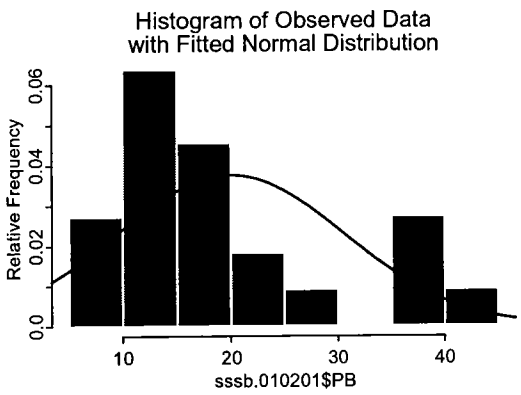


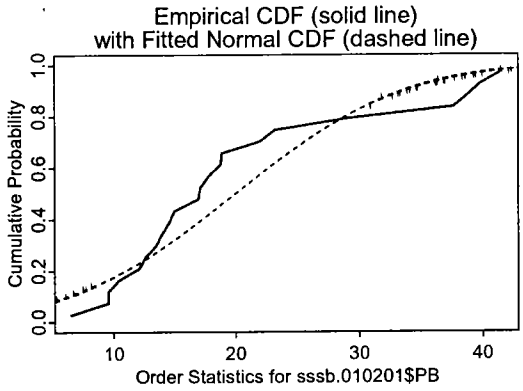


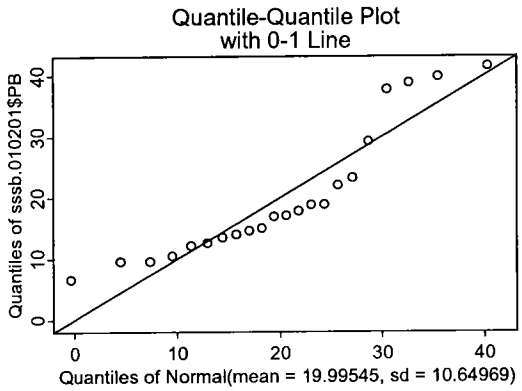
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 20.3 sd = 6.262891
Data:	sssb.010201$NI
Sample Size:	22
Test Statistic:	W = 0.8278497
Test Statistic Parmeter:	n = 22
P-value:	0.001411953

Results of Shapiro-Wilk GOF Test for sssb.010201$PB





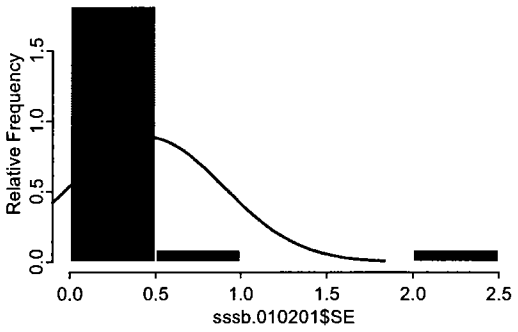


Results of Shapiro-Wilk GOF

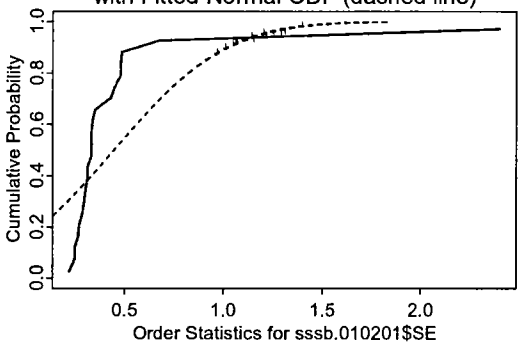
Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 19.99545 sd = 10.64969
Data:	sssb.010201$PB
Sample Size:	22
Test Statistic:	W = 0.8567034
Test Statistic Parmeter:	n = 22
P-value:	0.00447053

Results of Shapiro-Wilk GOF Test for sssb.010201$SE

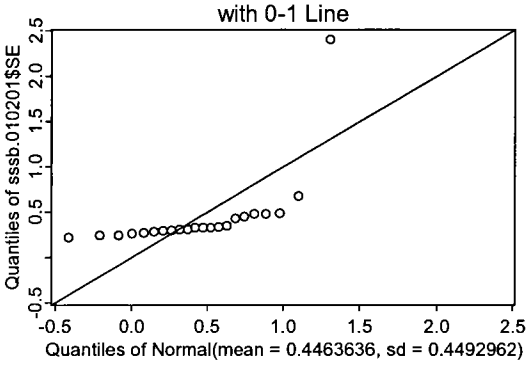
Histogram of Observed Data
with Fitted Normal Distribution



Empirical CDF (solid line)
with Fitted Normal CDF (dashed line)



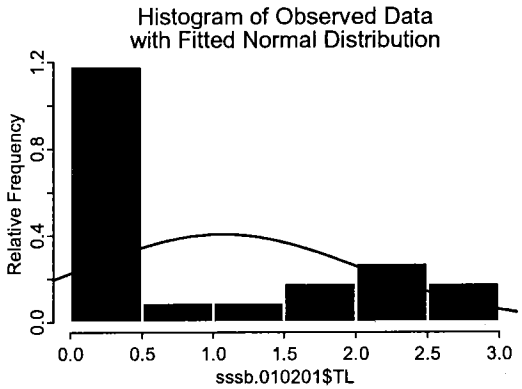
Quantile-Quantile Plot
with 0-1 Line

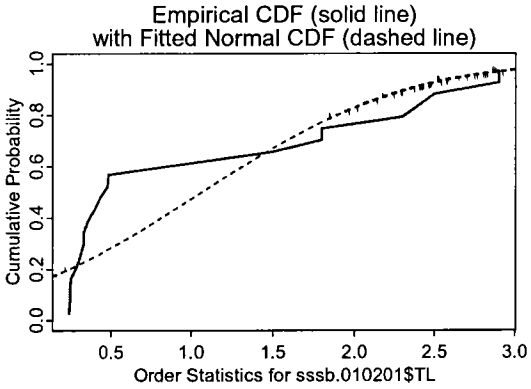


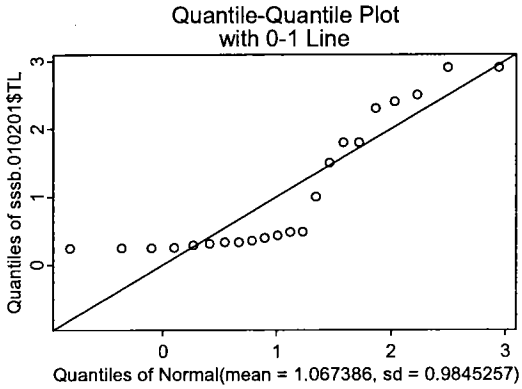
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 0.4463636 sd = 0.4492962
Data:	sssb.010201$SE
Sample Size:	22
Test Statistic:	W = 0.4161324
Test Statistic Parmeter:	n = 22
P-value:	2.344359e-8

Results of Shapiro-Wilk GOF Test for sssb.010201$TL



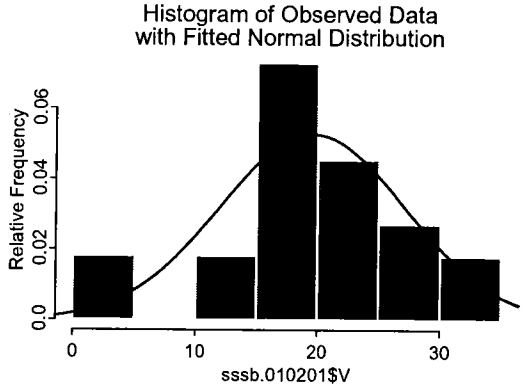


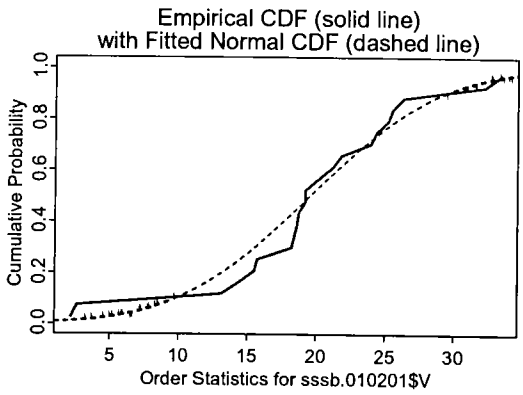


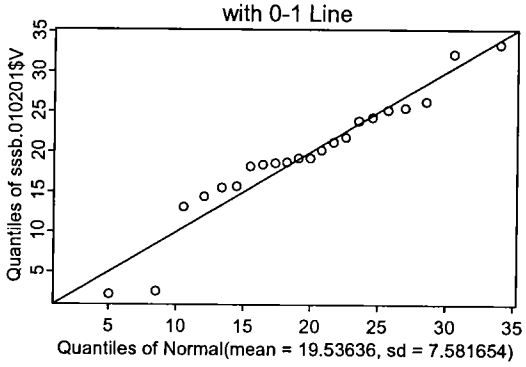
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 1.067386 sd = 0.9845257
Data:	sssb.010201$TL
Sample Size:	22
Test Statistic:	W = 0.7788632
Test Statistic Parmeter:	n = 22
P-value:	2.378779e-4

Results of Shapiro-Wilk GOF Test for sssb.010201$V



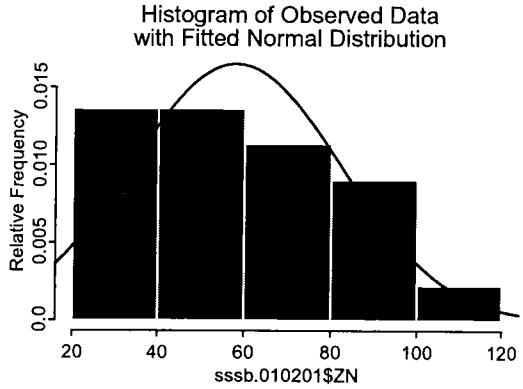


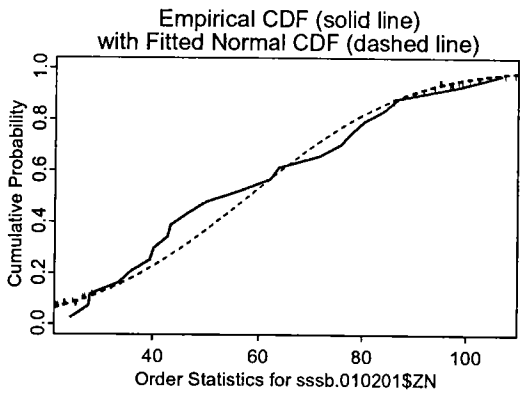


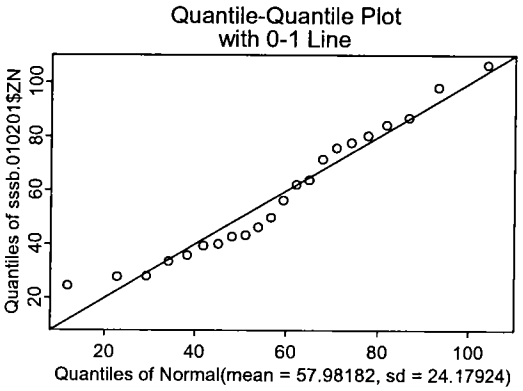
Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 19.53636 sd = 7.581654
Data:	sssb.010201$V
Sample Size:	22
Test Statistic:	W = 0.931963
Test Statistic Parmeter:	n = 22
P-value:	0.1348106

Results of Shapiro-Wilk GOF Test for sssb.010201$ZN







Results of Shapiro-Wilk GOF

Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 57.98182 sd = 24.17924
Data:	sssb.010201$ZN
Sample Size:	22
Test Statistic:	W = 0.9450643
Test Statistic Parmeter:	n = 22
P-value:	0.2513539